AMERICAN MACHINIST

A JOURNAL FOR MACHINISTS, ENGINEERS, FOUNDERS, BOILER MAKERS, PATTERN MAKERS AND BLACKSMITHS.

VOL. 18, NO. 15. WEEKLY. | NEW YORK, THURSDAY, APRIL 11, 1895. | $3.00 per Annum. SINGLE COPIES 6 CENTS.

COPYRIGHT 1895, BY AMERICAN MACHINIST PUBLISHING COMPANY.

For Sale Everywhere by Newsdealers. ENTERED AT POST OFFICE, NEW YORK, AS SECOND CLASS MATTER.

The Cornell Dividing Engine—II.

BY GEO. F. BALLOU.

Although, as I say, we considered that we had made only failures in the screws cut at Waltham, we had done some perfectly accurate work with the Waltham machine; we had not made a screw which was perfect under all the tests which we could apply, but we had measured the errors in some of the screws we made, and had found means by which the machine, while in operation, would correct these errors of the screw, and had made a very nearly true screw for Professor Meyer, of Stevens Institute, Hoboken, N. J. We had also done some work with the machine which was made the subject of a paper written by Professor Rogers, which was printed in the *American Journal of Science*, for January, 1880, and also was noticed in an article in the *Waltham Weekly Record*, of January 23, 1880. We also ruled on the 24th of November, 1880, a standard steel bar 6 inches long for the Pratt & Whitney Co. This bar was ruled with four lines 1 inch apart. "Also, lines representing—counting from the end of the second inch—the lengths corresponding to the *bottom* diameters or 'tap sizes' of the United States or Franklin Institute standard screw threads from a quarter-inch to 4 inches." See pp. 43, 70 and 153, "Standards of Length," edited by Geo. M. Bond, M. E., published by the Pratt & Whitney Co., Hartford, Conn., 1887. This bar was accurate, and was ruled by myself on the Waltham engine.

I have said that there was an interval of several months after work was stopped at Waltham and before we began again in Boston. It was during this lull of battle after the Waltham defeat that Professor Rogers gathered his forces together and decided upon a new line of action. Our experiments had taught us that while we could not take out long waves of error by grinding, we could take out short irregular imperfections; building on this dearly bought experience, Professor Rogers concluded that if we could find some means, no matter how rude and primitive, to bring the pitch of the screw right, say, at every half inch, we could then grind out our intermediate errors; and I saw as soon as he suggested his idea the mechanical means by which his plan could be carried out.

Professor Rogers had, before he came to the Waltham Company, a "comparator" with which he could divide a 6-inch length into half inches with accuracy, and having 6 inches in half inches we could produce a bar 24 inches or 26 inches long, divided into half inches, as accurately as the 6-inch bar was divided.

With a 26-inch bar divided into exact half inches and fastened to a lathe bed, we could easily find out the error of the lead screw of that lathe by simply putting a microscope on the tool carriage, and locking the lathe spindle with a latch in the big lathe spindle gear and setting the microscope to the first half-inch division mark, and then if the lead screw was 4 per inch, unlatching the spindle, giving the screw two turns and latching up the spindle again *should* bring the cross hair of the microscope on the carriage to exactly cover the second half-inch mark on the graduated bar. But if the lead screw was not accurate, then the microscope would have to be adjusted to make the cross hair and the bar division mark coincide, and the distance the microscope was moved to secure this coincidence would be the measure of error in that ½ inch of the lead screw. Consequently, if the microscope was mounted in a slide fitted to move lengthwise on the lathe carriage, and this slide was moved by a micrometer screw with an index reading, say, to $\frac{1}{10000}$ inch, then we could at once (from these micrometer readings) make a chart of the lead screw errors for each half inch of carriage travel. Also a screw threading tool could be carried on the microscope slide, and this threading tool might be moved by the micrometer screw, according to the dimensions of error on the lead screw chart, so as to bring the threading tool right at each half inch, as shown in Figs. 4 and 5. This was the method evolved by Professor Rogers and myself, and afterward patented by us jointly.

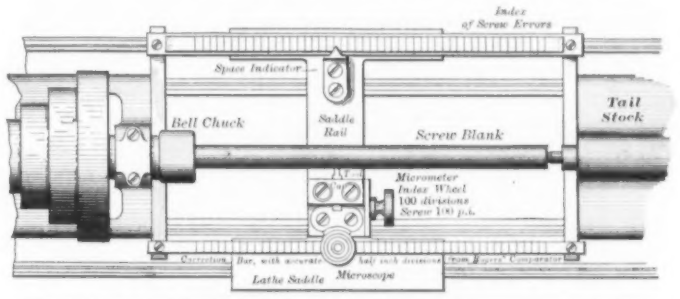
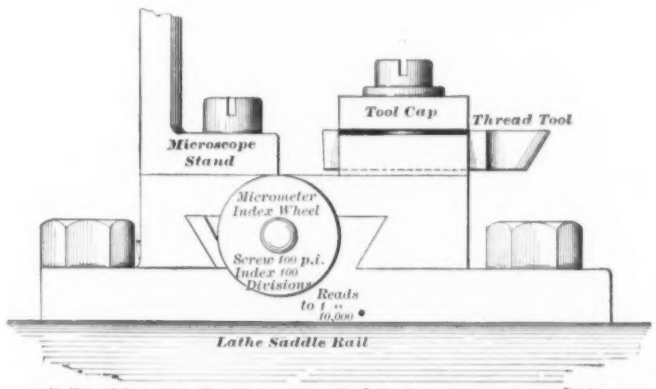


Fig. 4.—Sketch of Lathe with Correction Bar and Screw Error Index, as used in Cutting the Cornell Screw

American Machinist



R.H. Side.—Fig. 5.—Threading Tool Post on Micrometer Slide by which Lead Screw Errors were Corrected

American Machinist

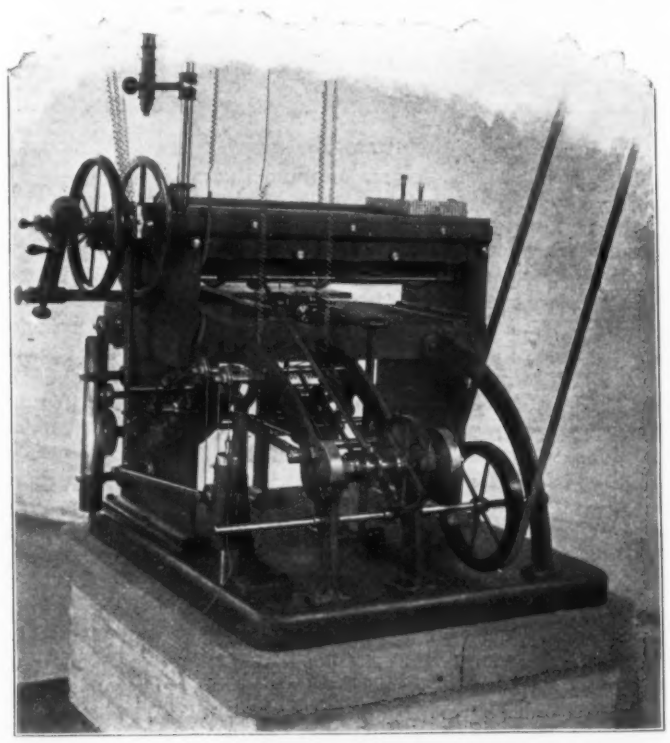


Fig. 9.

THE CORNELL DIVIDING ENGINE.

A room, with power, was rented at 35 Sudbury street, Boston, and equipped with one 13-inch by 8-foot Blaisdell engine lathe, one 6-foot by 24-inch Pratt & Whitney planer, one 20-inch Pratt & Whitney upright drill press, one American Watch Tool Company's bench lathe, with grinding fixtures and collets, all complete, and various other essentials for the work we intended to do. I hired a very bright boy, John Whowell, now in charge at the Blickensderfer Typewriter Co., Stamford, Conn., to help me, and we began operations looking once more to the production of the perfect screw.

The bar, with accurate half-inch graduations transferred from the 6-inch bar furnished from Professor Rogers' comparator, was made first and fastened to the head stock and foot stock of the 13-inch Blaisdell lathe, as shown in Fig. 4. The pitch of the lead screw of this lathe was 4 per inch, and the microscope and thread tool carrying slide was fitted with a micrometer screw reading to 0.0001 inch. Looking at Fig 4, which is a plan of the lathe, it will be seen that it was a perfectly easy job to read the errors of the lead screw. First of all, the "spaced bar" was brought so that its surface was everywhere exactly the same hight above the carriage ways of the lathe, so that its graduated surface would be in the focus of the microscope at all points; then the microscope was carried outside of the first graduation line to be used, the carriage moved by turning the lathe spindle connected to the lead screw with the 20 per inch change gears, until the cross hair of the microscope and the first used half-inch graduation mark on the bar coincided; then the latch was put into a tooth space in the large spindle gear, and that space was marked. Next, the lathe spindle was given 10 turns, and latched up again, and then the cross hair was brought exactly to the second half-inch graduation by moving the microscope slide with the micrometer screw, which was set at zero on the first graduation mark. The distance, plus or minus, of this slide movement was written down as the correction for the first half inch (or two turns) of the lead screw, and so on for the 48 bar spaces which covered the 24-inch length of perfect screw which was to be made. This was done over and over again, noting the movement, plus or minus, of the micrometer slide screw at each half inch, until we were satisfied of the correctness of each adjustment. Then the record strip of paper was secured to the record board at the back of the lathe, see Fig. 4, and this strip of paper was roughly divided by 49 lines, half an inch apart, and each space of the record paper was marked with the micrometer adjustment, plus or minus, to be made between that mark and the one next to the left, and the lathe was ready to begin threading the screw. During the operation of cutting the thread, the thread tool position was corrected by simply turning the micrometer slide screw forward or backward, according as the sign was plus or minus, the number of divisions called for by the record strip for that particular half inch which the tool was passing over at the time; this turning of the micrometer screw I did by hand. The lathe was run at a very slow speed, and as the "perfect screw" was 20 per inch, it made 10 turns for each half inch, and so gave me plenty of time to move the

micrometer screw and count the divisions, and bring the microscope cross hair and the half-inch division line on the bar exactly together at each half inch; so it was, after all said and done, a hand job at the end, as every piece of very accurate work is apt to be.

The tool post on the microscope slide is shown in Fig. 5. The tool was made so it would come exactly to place, and there was a fixture made for stoning the tool, so that the cutting edges were kept always exactly the same with the body of the tool. This may seem like a very rude, primitive method of correcting the errors of the lead screw, but it was so nearly successful that the greatest error in the finished screw, as measured by Professor Rowland, of the Johns Hopkins University, was only $\frac{1}{25000}$ inch. I do not know how this screw was tested to find this error of $\frac{1}{25000}$ inch, and if I did know the story it would not be likely to interest the readers of this paper, as such small errors are hard to find and locate with certainty, and are generally determined by averaging the results of a large number of trials by different observers. What I do know is that at the time this screw was made it was declared by those who were in the best position to judge to be a very much nearer approach to a perfect screw than had ever been made previously, and it may be a long time before a screw of the same length is made which has a smaller error.

I completed this screw in just two days and a half from the time I put it in the lathe. After we had tested it pretty thoroughly and were satisfied that it was nearly or quite perfect, the news of its production went to the Waltham shops where it was received with incredulity, as our failures had led to the belief there that a perfectly pitched screw could not be made. I need hardly say that this near approach to perfection was a great personal satisfaction to me.

After this screw was cut, I cut a nut in the lathe by the same method, using the micrometer tool slide screw adjustment, by hand, as before. This nut was made in halves, of brass, and was used to grind out the short errors between the half inches in the "true screw," which was *not* true, of course. An absolutely perfect screw can never be made, and if made it would take years to conduct such a series of measurements as would prove its absolute correctness. The greatest experts living differ in their readings of extremely small measurements, and temperature is so great a factor of the length of metals that it is often a very difficult matter to determine how much longer one piece is than another piece, when the two are very nearly one length.

In cutting this screw no temperature precautions were taken; there was no need to do more than to run slowly and avoid heating the blank by the action of the tool or the friction on the dead center, because we were making no effort to cut a screw of a definite length; uniform pitch was our object. I afterward, at Hartford, did try to make long screws of exact lengths, and, although that trial was unsuccessful, I still believe it possible to copy an accurate screw of any ordinary length, but it would take far too much space here to go into that matter. I have lately heard that Professor Rogers now has a perfect screw 60 inches long. I do not know where or how it was made.

We had found cause in the experiments with the Waltham dividing engine to doubt the correctness of the "shaper" form of the machine. The feature of giving the diamond a movement to make the mark appeared to open the way for errors in precisely the same manner that errors came into planing done on a shaper. Mounting the work table directly on the feed screw was considered objectionable, also. We therefore abandoned the shaper form of machine, and put the "Cornell dividing engine" into the planer form, as shown in Figs. 9 and 10. The marking diamond is mounted, as shown in Fig. 6 (page 241), being held in the cup with a cement of shellac mixed with brick dust. This shellac and brick dust cement sticks tight to a diamond, and by warming the holder, the diamond can be moved a little very easily and quickly; which are points of great advantage.

Professor Rogers knew that by the use of the grinding lathe round bars could be made which were very nearly perfect, and he therefore was very much in favor of using such round bars for guides or ways on which the tool holder travels along as it is moved by the action of the screw. I do not myself believe that round bars, generally speaking, are to be preferred to ordinary V or dovetail slides or guides, but the round bars were used in the Cornell engine. The tool slide rests upon two round guide bars, one of these being directly behind the lower bar seen in Fig. 10, while above it is the dividing screw which represents so much of time and labor. Above the screw is another round guide bar, on which rests a slide carrying a microscope. Below, on top of the bed of the machine, is a fourth round guide bar, set at right angles to the other three, and forming the way on which the work table is moved back and forth by a crank action to make the work travel under the marking tool. This work table rests on the round guide, and also on a flat surface at the farther edge in Fig. 10, which supports the work table in a horizontal position. The microscope slide on top of the machine is similarly supported on the flat top surface of the cross bar, as shown in Fig. 9.

In the face of the dovetail quadrant tween the two links of the double-connecting rod, reaching inward from the top end of the long vertical rocker, driven by a connecting rod from the right hand slotted disk crank on the cam shaft in Fig. 9. The two inner ends of the connecting links at the top of the vertical rocker took hold of a yoke which embraced the inner end of the sliding double-flanged segment, so that the segment could be rotated partly on the round rod which served also as a guide for the double-flanged segment to slide on; the work slide driving lug stood between the two segment flanges, and did not fill between the flanges by $\frac{3}{8}$ inch or $\frac{1}{4}$ inch, and each flange had three screws in it, the six screws being in opposing pairs, set so as to vary the lost motion of the driving lug between the segment flanges, so that a constant movement of the long vertical rocker could be varied into three different lengths of work holder travel, according as the double-flanged segment stood in either of the three positions, which made one of the three pairs of the segment adjusting screws operate to drive the work slide. This flanged segment position governing cam was rotated intermittently by a 10-tooth ratchet operated by a pawl driven one double stroke by a cam on the cam shaft for each revolution of the cam and crank shaft. The operation is to hold the double-flanged segment in one position for four strokes of the work slide which make the four short marks; the cam then varies the flanged

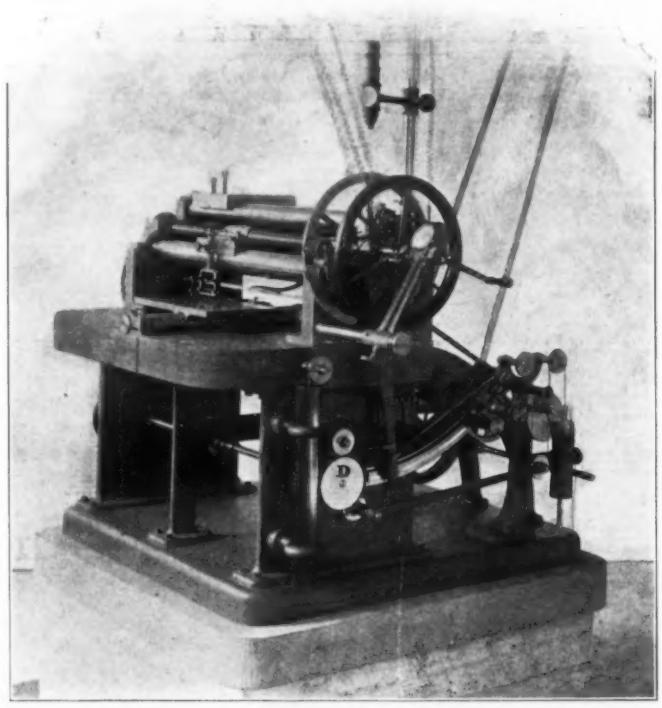


Fig. 10.

The Cornell Dividing Engine.

traversed by the free end of the screw moving bell crank which carries the magnets, Fig. 10, the engraving shows a bright strip; this is a graduated piece of silver let into the quadrant; the graduations are numbered and give the arm travels in units of large dimensions; the finer dimensions of arm travel are fixed by the position of a micrometer screw in the sliding block dovetailed on the quadrant; by setting the dovetail block to a recorded mark on the silver strip, and bringing the micrometer stop screw to a recorded number, any graduation once made can be exactly duplicated.

In the rear view, Fig. 9, the belt is shown leading to a wooden rim pulley on the shaft carrying the pinion which meshes into a large spur gear on the cam shaft. The cam shaft carries four cams between the journals and two slotted disk cranks, one outside of each journal. One of these four cams operated the long slender rock shaft above, carrying the diamond lifter, to keep the marking tool off the work on the back stroke. The difference in the lengths of the marks, every fifth mark being longer than the preceding four, and every tenth mark longer than the fifth marks, was made as follows: One ratchet-driven cam rocked a swinging double-flanged segment, which was also mounted to slide on a round rod located be-

segment, so that another set of screws drive the slide lug a greater distance for the fifth stroke, and then turn the segment back to the short stroke pair of screws for four more marks, and again rock the segment to bring the third set of screws into work slide driving position for the tenth longest mark. The long arm reaching down from the slender top rocker to the cam shaft rests on the cam which lifts the tool by means of the long straight edge at every return movement of the work holder. The remaining two cams on the cam shaft make and break the contacts for the screw disk and swinging arm respectively. The disk *D* (Fig. 10) is driven even turns with the screw by gearing down the rear side of the rear frame, and it serves as a stop for the screw-driving arm at the left extreme of its stroke, and was used instead of a simple fixed stop, so that if there had been a "one-turn error" in the screw, that is, any error which was constant and repeated itself at each revolution of the screw, such error could have been corrected by cutting the edge of this revolving stop disk into a cam. As there was no perceptible one-turn error in the machine this device was not needed, and the disk was not cut into a correcting cam, but left circular in form, as there was nothing for it to correct. The screw disk had a band of silver dovetailed in the middle of its face, and this band was graduated into 100 equal divisions as follows: First, a fine scriber mark was made on the rim of the screw wheel; next the microscope was placed so the cross hair exactly covered this mark; then the driving arm stop was set by guess to turn the screw wheel one revolution for 100 revolutions of the crank shaft. This was repeated until the scriber mark on the wheel rim came exactly back again under the cross hair of the microscope, after 100 turns of the cam shaft had been made; then a slide carrying a diamond marking tool was fastened to the frame, and the silver band in the face of the screw wheel was marked in 100 divisions with the diamond. These divisions gave, of course, $\frac{1}{100}$ of $\frac{1}{20}$ inch $= \frac{1}{2000}$ of an inch marking tool movement for each division on the screw wheel. Then the microscope was fitted with a micrometer eye-piece by which each of these divisions on the wheel could be divided into 100 equal divisions, so that the wheel was practically divided into 10,000 divisions, and one division in this eye-piece represented $\frac{1}{20000}$ of an inch of cutting tool movement, and yet the divisions in the eye-piece appeared to the eye so large and distinct that they could readily be subdivided by estimation into 10 equal parts, one of these ultimate divisions thus representing $\frac{1}{200000}$ of an inch of tool movement.

The diamond lifter was given a movement from a cam which would hold the diamond off the work through each entire alternate revolution of the cam shaft at will; by this means any division in process of making could be doubled without changing anything at all; if the machine was set to rule lines, say, $\frac{1}{1000}$ of an inch apart, by throwing this alternating cam into action, the marks would be made only at each alternate revolution of the main cam and crank shaft, or $\frac{1}{1000}$ inch apart, and the position of the screw wheel could be watched through the microscope at each 2,000th of an inch position.

The screw-driving magnet carrying arm of the Waltham machine was carried out horizontally, and operated the screw by the gravity of the arm, and made us much more trouble by shock when the arm struck the lower limit stop. To avoid this the driving arm in the Rogers-Ballou machine was made to stop in a vertically down-hanging position. It was operated by two cords, one of which, passing under and over pulleys to the left in Fig. 9, and taking hold of a weight rising and falling in the vertical tube seen in front in Fig. 10, did the work of moving the screw. The cord leading to the right passed over the first of the two pulleys seen at the extreme right, then down under a pulley on the right-hand end of the long crank-driven rocker arm, and then up over the outside cord pulley and down to another weight, all as clearly shown in Fig. 10. By this means the rocker arm could have an over-travel, and by adjusting the mass of the weights a perfectly soft and unvarying motion of the screw-driving arm was obtained. The stud, inclined arm, and registering dial driven by a hand crank seen at the right served to drive the screw by hand, and to record the whole number of screw revolutions.

As soon as I had the machine assembled I, of course, tried to rule a plate, and, to my consternation, found the diamond did not make straight lines. This was totally unexpected, but as the lines persisted in being crooked, and had no regularity in their crooks, I pulled the machine down and spent two weeks of most anxious toil in trying to find a fault in the fitting to account for the bad lines. Everything seemed right, and I was more worried than ever before or since over a piece of work. One Saturday night it struck me that the heavy street traffic might be the cause of the crooked marks, and I went to the shop bright and early on Sunday, a day of still streets in Boston, and ruled a plate which showed absolutely perfect lines. That was one of the happy moments of my life, and as I said at the outset, I always smile when I think of my feelings during the two weeks

I was hunting for the cause of the crooked lines. After thorough and most satisfactory tests the machine was finally shipped to Cornell University on Wednesday, September 12, 1883.

Two-spindle Milling Machine.

We give on this page illustrations of a two-spindle milling machine which is adapted to many jobs now done on single-spindle machines, and, of course, will do the work considerably faster.

This machine, as clearly shown in the illustration, consists of a box bed 9 feet long with extension on back supporting the upright which carries the overhanging arm, to which are fitted the two saddles, carrying the spindles.

The belt which drives the spindles also drives the feed mechanism. The spindles are made as per drawing, Fig. 2, and extend to 2 inches below spindle head. They are made with 1⅜ inches diameter, conical bearing at lower end, and 1¼ inches straight bearing at upper end, each provided with bronze bushings. These spindles can be adjusted on crosshead to within 2½ inches from center to center, and the extreme movement separates the centers to 14 inches, which admits of the spindles reaching to the edges of platen. Each spindle head has ½ inch independent vertical adjustment by means of an adjusting screw on front of each saddle.

The adjustment of the crosshead on the upright is by a screw, provided with a pilot wheel, as shown, on top of upright, and the movement is such as to allow the ends of spindles to reach the table, or platen, or to raise them to 17½ inches above it, a graduated dial reading to thousandths of an inch facilitating accuracy of adjustment. The dial is provided with movement independent of screw, which allows it to be placed at any figure desired.

The platen is 6 feet long inside of end pans, and is 14 inches wide. There are three tee slots extending the whole length, and the depth of platen is 5 inches. The feed is 6 feet 4 inches, by hand or power, and is provided with automatic stop.

Two countershafts are provided with the machine, the first runs at 210 revolutions per minute. Each countershaft has a three-section cone pulley which admits of three speeds to second counter, which drives machine spindles at the rate of 41, 56 and 76 revolutions per minute, and the machine is so belted that the tension of driving belt is not altered by the vertical movement of the crosshead on the upright.

There are 12 rates of feed to the platen, ranging from 2 inches to 8½ inches per minute at any of the spindle speeds. Pulley on spindle-driving shaft is 16 inches diameter for 3-inch belt. Spindles have No. 3 Morse taper holes.

The upright is 18 inches wide on the face, and extreme hight of machine is 7 feet. Its weight is 8,000 pounds. It can, of course, be readily modified to suit special requirements, and is furnished with horizontal spindle when desired. It is built by Beaman & Smith, Providence, R. I.

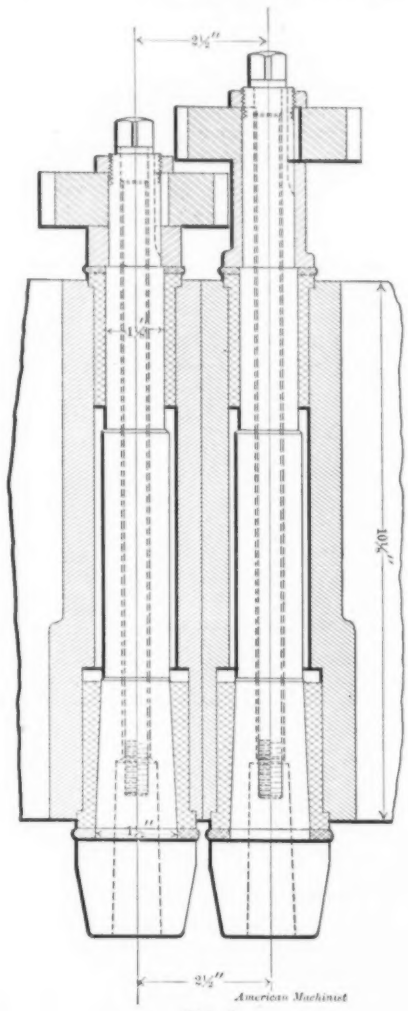


Fig. 2.

An Oil Can Filler.

The desirability of a device by means of which oil cans can be filled quickly and absolutely without waste of oil will be readily conceded by any machinist or engineer, and we illustrate herewith a device by which this feat can easily be accomplished.

As shown by Fig. 1, it is a pump with a flange by which it is readily attached to a tank of any kind, or a barrel, a suction pipe extending below into the oil. The pump has a brass barrel and piston, the former being 1¼"x12" long. Leather packing is used, and the valves are hard steel balls.

The discharge nozzle is double, *i. e.*, there are two tubes, or openings concentric with each other, the smaller one supplying the oil to the can, while the larger one vents it, and returns all surplus oil to the tank by means of the tube seen at the right.

In operation, an oil can to be filled is placed upon the table, which is then raised until the opening in the can comes in contact with the conical discharge spout, a leather washer making the joint tight. The pump is then worked until the can is filled, and when stopped the overflow tube siphons off from the can a small quantity, sufficient to permit the spout to be screwed in without displacement of oil. Less than ten seconds suffices for a common oil can, and not a single drop of oil need be wasted or spilled.

Fig. 1 shows it with a side spout by which any vessel, such as a pail, can be rapidly filled, the cock switching the discharge to this spout when desired. It is also made without this feature, as shown in Fig. 2. The manufacturer is F. D. Winkley, Madison, Wis.

The prices of good second-hand tools and other machinery have generally advanced, and this is regarded as a very good indication by those whose business it is to watch symptoms.

An Example of Co-operative Contract and Piecework.

BY M. COKELY.

That able paper on the co-operative contract system, by Mr. Richards, in your issue of November 15th, has tempted me to give some of my experience in establishing that system in the largest electrical manufacturing works in the country. A few years ago that company very wisely decided that the "time" or "day-work" system, under which they were then working, should be superseded by "piecework." This decision, I believe, was not so much a matter of choice as of necessity. The writer was selected to work out the problem, and will forever remember his job.

Fig. 1.

To be brief, the individual system was the first introduced. Every operation had its price, molding, planing, milling, drilling, filing, boring and turning, and all the various operations through which each part of the machines passed, was estimated, and the price fixed. At the erecting floor the first obstacle to the individual system was met. In the assembling of a machine, especially a large one, a gang of men is absolutely necessary, and as it is impracticable to subdivide this operation so that the labor of each would be definable, we decided that all should work together and share together in the profits of the gang. It was in this way that the co-operative system forced itself upon us. The next question was the distribution of profits or loss among the various members of the gang. On the rolls, of course, each man is rated at a certain sum per hour, which rating is supposed to be adjusted according to merits. Taking that rating and the number of hours worked during the week, as a basis, the distribution was made as follows: A. is rated at 25 cents per hour, B. 20. A. works 60 hours, B. 50. Their earnings, according to rate, being $15 and $10, respectively; a total of $25. The product of their labor for that week, according to the price paid for it, amounted to $30, leaving a profit of $5. As A. earned 60 per cent. of the $25, he should be entitled to 60 per cent. of the profits, or $3, which, added to the $15, makes his entire wages $18. And as B.'s earnings only show 40 per cent. he can claim only 40 per cent. of the profits, or $2, making his total for the week $12.

	Rate.	Hours.	Total.	Per cent.	
A.	25c.	60 =	$15 =	60 =	$3 = $18
B.	20c.	50 =	$10 =	40 =	$2 = $12
			$25		$5 $30

No more just or equitable method of distribution could be imagined. Gangs were organized throughout the works, each with its leader or gang boss who was rated slightly higher than the others. A co-operative gang unloaded the raw material from the cars, another made the packing cases for the finished product, another packed it into the cases ready for shipment, and still another placed it on the cars, and throughout all the different departments, where the requirements demanded it, gangs were organized, and, in fact, some places where the requirements did not demand it. For instance, engines were built co-operatively, although a price was recorded for the necessary operations on each separate part; all completed parts being reported by operations, and credited to the gang, instead of the individual. The piecework principle was applied wherever possible, even to tools and repairs, until over 90 per cent. of the total productive pay-roll represented piecework. Cutters were ground on piecework at so much per tooth. Lathe centers, arbors, etc., were made and repaired on piecework; even to the cleaning of the windows. If a bolt was to be made in an engine lathe, there were prices for turning, threading, facing the head, facing under the head, cutting off, milling and polishing, each separate and distinct, so that if in the assembling of a machine a bolt was found to misfit, it was passed to the lathe hand who performed the necessary operation, and by consulting a tabulated list of prices he knew from the dimensions just what he would receive for it. To describe all the rules, tables, lists, forms and methods generally by which the entire system was regulated and developed, would require more space than you would be likely to give to a communication of this kind. That this policy was highly beneficial to the company's interest cannot be doubted; so much so, in fact, that although burdened with an enormous general expense they have successfully "weathered" the recent industrial storm and the biting influence of close competition. This would not have been possible under the time system, as the writer saw it administered prior to the introduction

Fig. 2.
OIL CAN FILLER.

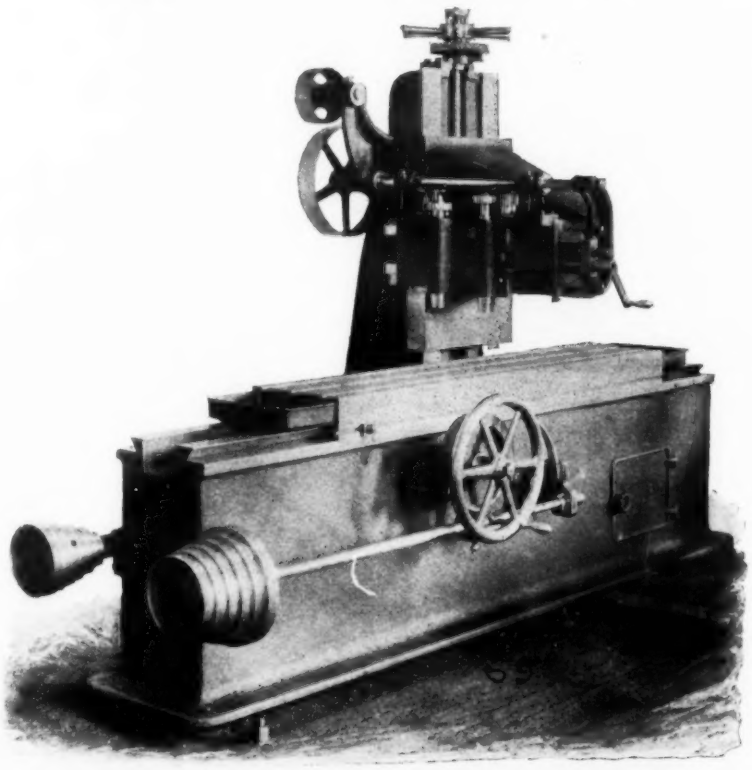


Fig. 1.
TWO-SPINDLE MILLING MACHINE.

of piecework, when it might be characterized as little short of downright robbery. And this is true of many establishments throughout the country to-day. A workman to all appearance may be busy, but whether he is accomplishing as much as he should, is altogether a different thing. He will protest that he will do as much by working day work as piecework, but I have never yet seen the statement made good.

Having the advantage of a practical experience, I was able to decide pretty nearly what a day's work should consist of, and in setting and adjusting the prices that point was constantly kept in view. By this means the amount of reduction that was made in the cost of production was in many cases nearly incredible. It required considerable effort to convince the help that by the introduction of piecework generally, and co-operation particularly, no injustice was intended. But once assured of that fact they took hold willingly, and their weekly earnings averaged more than under the time system. In addition they did better work, and to all appearance were better satisfied. The only case of real discontent was shown in the pattern shop, where piecework in any form was not introduced. They were allowed to work on the time system and at rates that averaged higher than any other department in the works.

In conclusion, I will submit these few general opinions:

An establishment conducted on the day-work plan cannot compete with one on piecework; and the bleached bones of many industrial enterprises that strew the land cannot all be attributed to the "plunging" business methods peculiar to the nation, but in nine cases out of ten, I am confident, can be traced to the day-work system.

As to the relative merits of individual and co-operative piecework, I will say that to reduce the cost of production to its lowest possible limits, the individual system is preferable. But the best general results can be obtained by a judicious use of both.

New Throttling Compound Engine.

The accompanying illustration is that of a new non-condensing cross compound—cranks 90 degrees apart—throttling engine, for which the builders claim good economy, with steam as low as 80 pounds per square inch.

The aim of the builders has been to provide an engine that will function between wide limits of power, without "looping" by reason of the terminal pressure falling below the back pressure line—and for this reason a fixed cut-off and throttling regulation were selected. The engine has been constructed in the simplest manner deemed consistent with efficiency. The valves are plain slides, driven by single eccentrics, and are fitted to remain tight and serviceable without continual overhauling. They are placed on the sides of cylinders—to allow easy escape for water, and so reduce the possibility of accident from priming. The high-pressure cylinder is thoroughly jacketed, and it is claimed that steam is delivered to the low-pressure cylinder in a practically dry condition. The combined diagram of one of these engines, a 225 (maximum) horse-power electric lighting engine, which is running in a station near Cincinnati, is shown by Fig. 2, from which the close division of power between the cylinders can be seen.

The builders state that their 40 horse-power (maximum) engine has been run light with the division 7.7 horse-power and 9.5 horse-power, and when loaded, at 19.4 horse-power and 18 horse-power. Each engine is supported upon a cast-iron base that is flanged to catch all drip of oil or water. The pistons and all members are easily removed, for inspection and repairs, and all parts admit of efficient lubrication.

These engines are built by Houston, Stanwood & Gamble, of Cincinnati—who are prepared to furnish any size, from 25 horse-power to 400 horse-power, for steam pressures ranging between 80 and 120 pounds gauge. Some thirty-three sizes are regularly built, which are designated by numbers in such a way that the number being multiplied by the pressure and again by the revolutions—the product, divided by the constant 10,000, equals the maximum indicated horse-power. Thus engine No. 64, for instance, at 90 pounds steam, and 160 revolutions, will develop $\frac{64 \times 90 \times 160}{10{,}000}$ = 92 I. H. P.

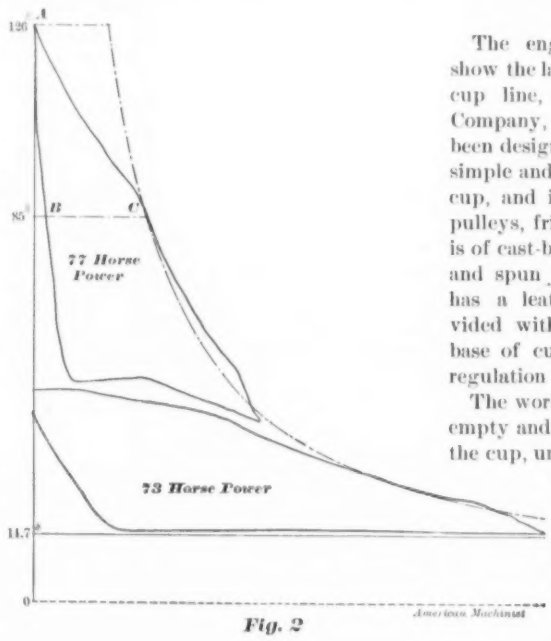
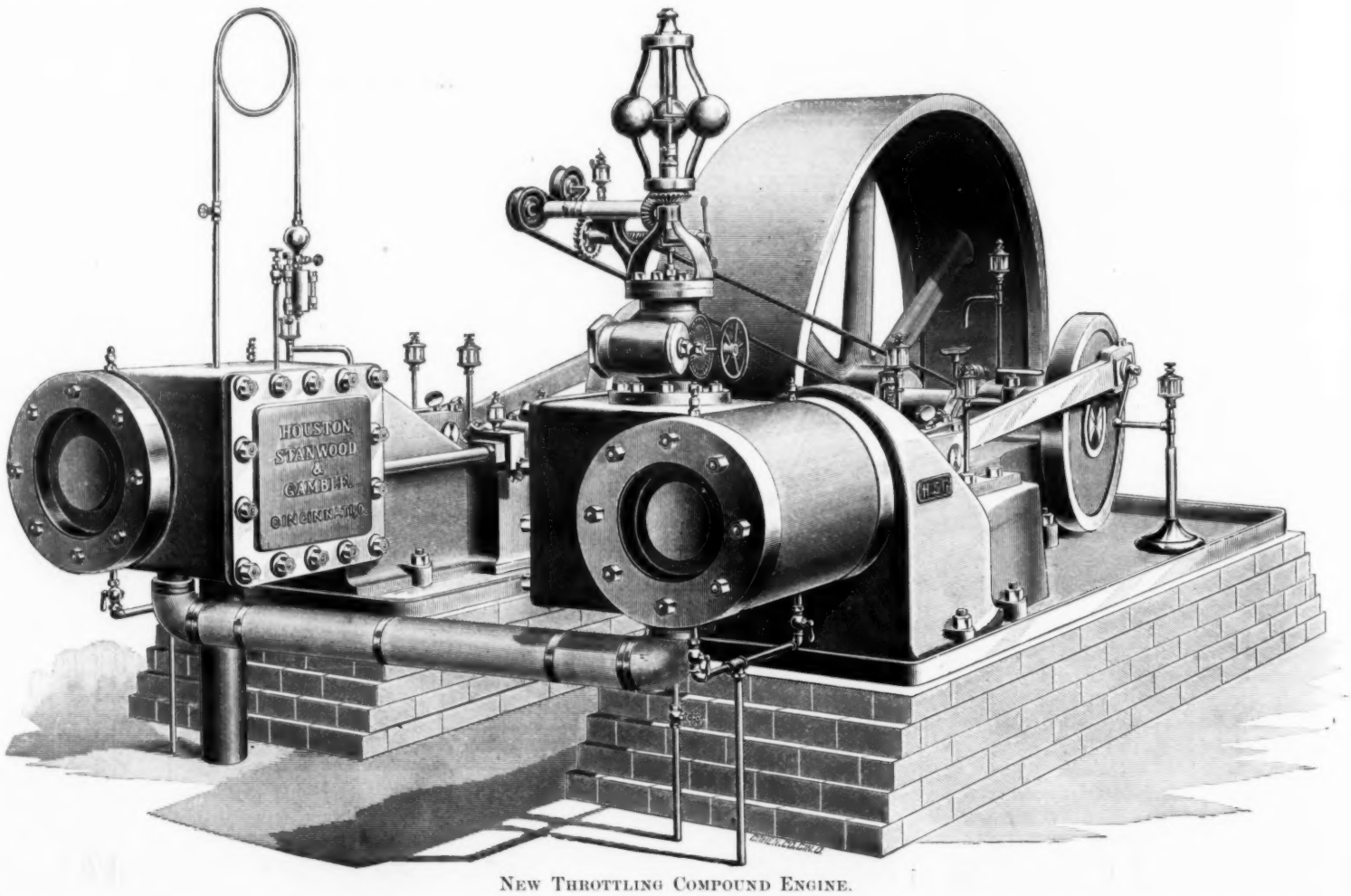


Fig. 2



New Throttling Compound Engine.

The Immortal Keely.

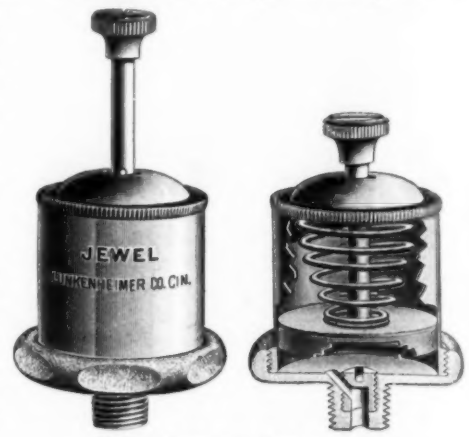
George H. Peabody, of New York, writes to *The Sun* to say in effect that Keely's vibratory force is about to vibrate and his motor about to mote. In other words, he has gained command of an accumulation of costless force drawn from the atmosphere, or, as he expresses it, "a sympathetic force of outreach representing in the full receptive circuit an accumulation of polar sympathy of more than twenty-three tons when under rotation to be distributed to the polar and dipolar circuits" of his machine.

It is announced that "next month a number of scientific and business British gentlemen will be here to visit Mr. Keely." In the meantime, of course, subscriptions will be received from Americans who may be anxious to prevent the Britishers from swallowing this, another of our great industries.

The Lunkenheimer "Jewel" Grease Cup.

The engravings presented herewith show the latest achievement in the grease cup line, made by the Lunkenheimer Company, of Cincinnati, Ohio. It has been designed to meet the demand for a simple and inexpensive automatic grease cup, and is adapted for shafting, loose pulleys, friction clutches, etc. The base is of cast-brass, while the top is of tubing and spun brass. It is of brass throughout, has a leather-packed plunger and is provided with a feed-regulating screw in the base of cup which will admit of perfect regulation of feed.

The working of cup is as follows: When empty and the plunger is at the bottom of the cup, unscrew and take off the reservoir; then lift the plunger to top and fasten in this position by means of the lock arrangement, then fill the reservoir with grease, screw it back into its base, release the spring lock so as to put the pressure on, and the cup again feeds automatically until empty. The feed-regulating screw in base of cup permits of adjustment of the opening through the shank of the cup to suit any kind of grease.



The "Jewel" Grease Cup.

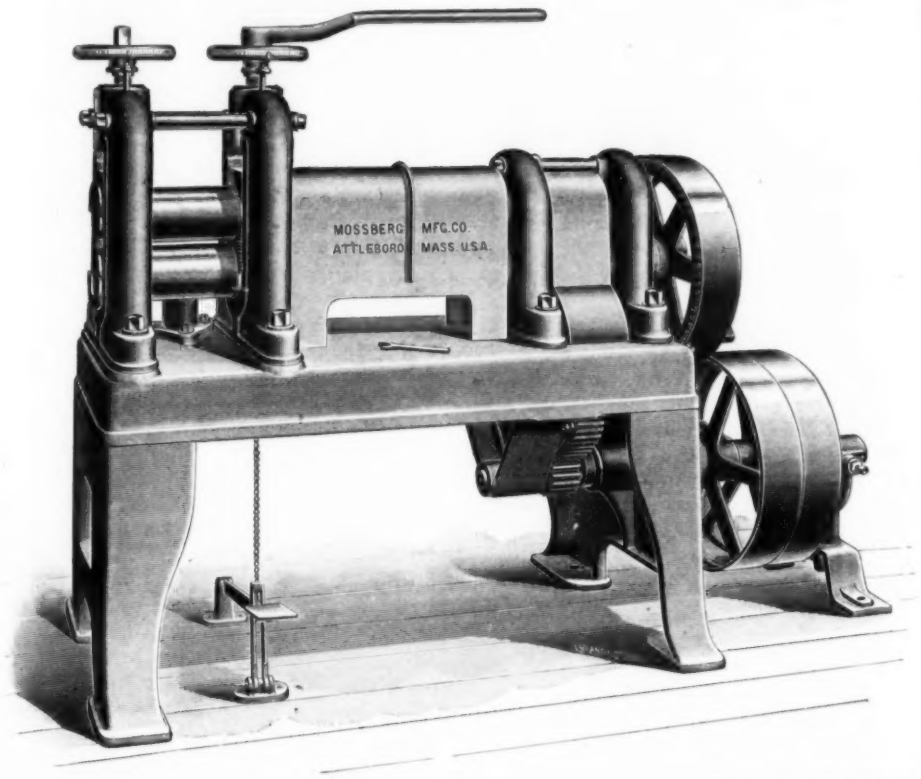
Rolling Mill for Sheet Metals.

The engravings (page 285) represent a rolling-mill of new design, that is especially adapted for rolling brass, silver, gold, tin foil, etc., but can be used equally as well for rolling sheet steel. The machine shown is what is known as a 5-inch by 8-inch mill, that is to say, the diameter of the rolls is 5 inches and the length of face 8 inches. The mill is provided with 24-inch by 5-inch tight and loose pulley and is geared 16 to 1. All the bearings for the pulley and gear shafts are bushed so that in case of wear these bushings can be removed and new ones readily put in. All gears are machine cut. The gear housing (Fig. 2) is shown partly in section, and the bearings for the gear shafts are fitted with phosphor-bronze bushings. The gears (Fig. 2) are cut on a spiral or angle of about 12 degrees, as is shown. These gears are what are usually termed "herring bone" gears, a name which, in our opinion, is very unscientific, but will be understood nevertheless. The object of introducing this style of gears is to secure smooth and even running under heavy strain. It is well understood that the housing gears are subject to a very heavy strain and wear, which soon causes a rolling-mill to chatter; this trouble is usually transferred to the rolls and from the rolls to the sheet stock that is being rolled, which comes out wavy and uneven—a very serious objection which is entirely obviated in this mill on account of the gears being made as above described.

The roll housing is fitted with the Mossberg anti-friction roller bearing, by which the friction from the roll journals is reduced to a relatively very small amount, and hence there is no heating in running. It is claimed by the manufacturer that the machine here described will run constantly without interruption and at a speed much greater than is possible with a mill fitted with the old style

of bearing, it being well known that on account of heating from friction in running, machines of this class are often obliged to stand idle about half the time to cool down. A great saving in power is also effected, tests indicating a saving of from 50 to 75 per cent. in producing the same amount of work. The hand wheels are graduated to $\frac{1}{1000}$ of an inch to facilitate setting.

These mills are built in eight sizes, with rolls varying from 3 inches to 12 inches diameter and 5 inches to 18 inches face, by the Mossberg Mfg. Co., Attleboro, Mass.



Rolling Mill for Sheet Metals.

Engines of the Steamship "Howard."

The steamship "Howard," which will be the latest addition to the fleet of the Merchants' and Miners' Transportation Co., running between Baltimore and Boston, is in course of construction at the yards of the Harlan & Hollingsworth Company, Wilmington, Del. The engines, of which we give an illustration, are of the direct triple-expansion type, with inverted cylinders, high-pressure cylinder, 24 inches diameter; intermediate, 39 inches diameter; and low-pressure, 59 inches diameter; stroke, 48 inches.

A piston valve is used for the high-pressure cylinder, and double-ported slide valves for the intermediate and low-pressure cylinders; the latter valves are fitted with springs on the back. The piston rods, tail rods, and crank shaft, which latter is of the built-up type, are made of hammered scrap iron. The valve rods are made of steel, with balance pistons at the upper ends of the intermediate pressure, and low-pressure valve rods.

The lower ends of the piston rods are secured with nuts to wrought-iron cross-heads, and the latter have cast-iron shoes, fitted with bars of white metal. The packing boxes and glands are bushed with brass, and fitted with Katzenstein's metallic packing. The piston rods, and the connecting rods also, are interchangeable. The cross-head pin brasses are of phosphor bronze, and the crank-pin brasses are of hard brass lined with white metal. The bed plate is made of the box form, cast-iron, with circular recesses for the main bearings, which are made of hard brass. The water service pipes are 2 inches diameter, of brass, and reduced to suit the requirements for circulating water through the main journal brasses. The condenser is of cast-iron, with brass tube heads arranged for ¾-inch solid drawn brass condenser tubes; these are arranged horizontally. The tubes are arranged in two sections, water passing through the tubes in the upper section, and returning through the tubes in the lower one.

The tail shaft is fitted with a sleeve extending from wheel hub to a point 6 inches forward of packing box gland. The sleeve is bored and shrunk on shaft, and further secured by countersunk screws. The stern tube is made of cast-iron, and securely fitted into a recess bored into the stern frame of the ship. The brass bushing is fitted with strips of lignum-vitæ placed on end. The thrust block is fitted with brass collars in cast-iron block, lined with white metal, fitted for water circulation, and a tight box filled with oil for lubrication. The propeller, four-bladed, is 16 feet in diameter, 23 feet pitch, with blades bolted to the hub. The tunnel has a water-tight door aft of the thrust bearing, and stuffing box, with gland around shaft through bulkhead. The vessel will have six water-tight bulkheads. Four Scotch boilers will furnish steam. These boilers are 12 feet diameter, and 13 feet 6 inches long. The dimensions of hull are: Length between perpendiculars, 270 feet; length over all on deck, 293 feet; beam molded, 42 feet; depth, 34 feet; shear forward, 6 feet 6 inches.

Steel will be used throughout the construction of hull. The vessel will be heated by steam, and lighted by electricity, and particular attention will be given to the safety and comfort of the passengers, so as to place the steamer among the most popular coastwise and seagoing steamships.

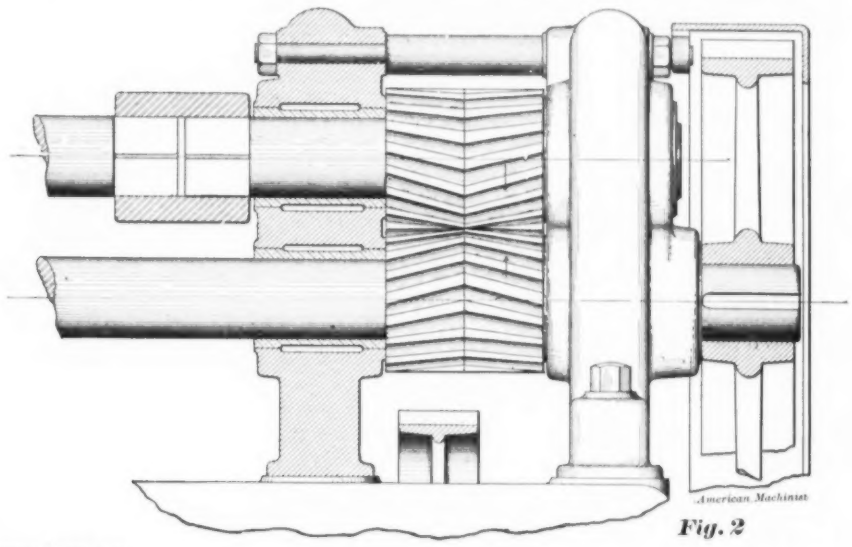
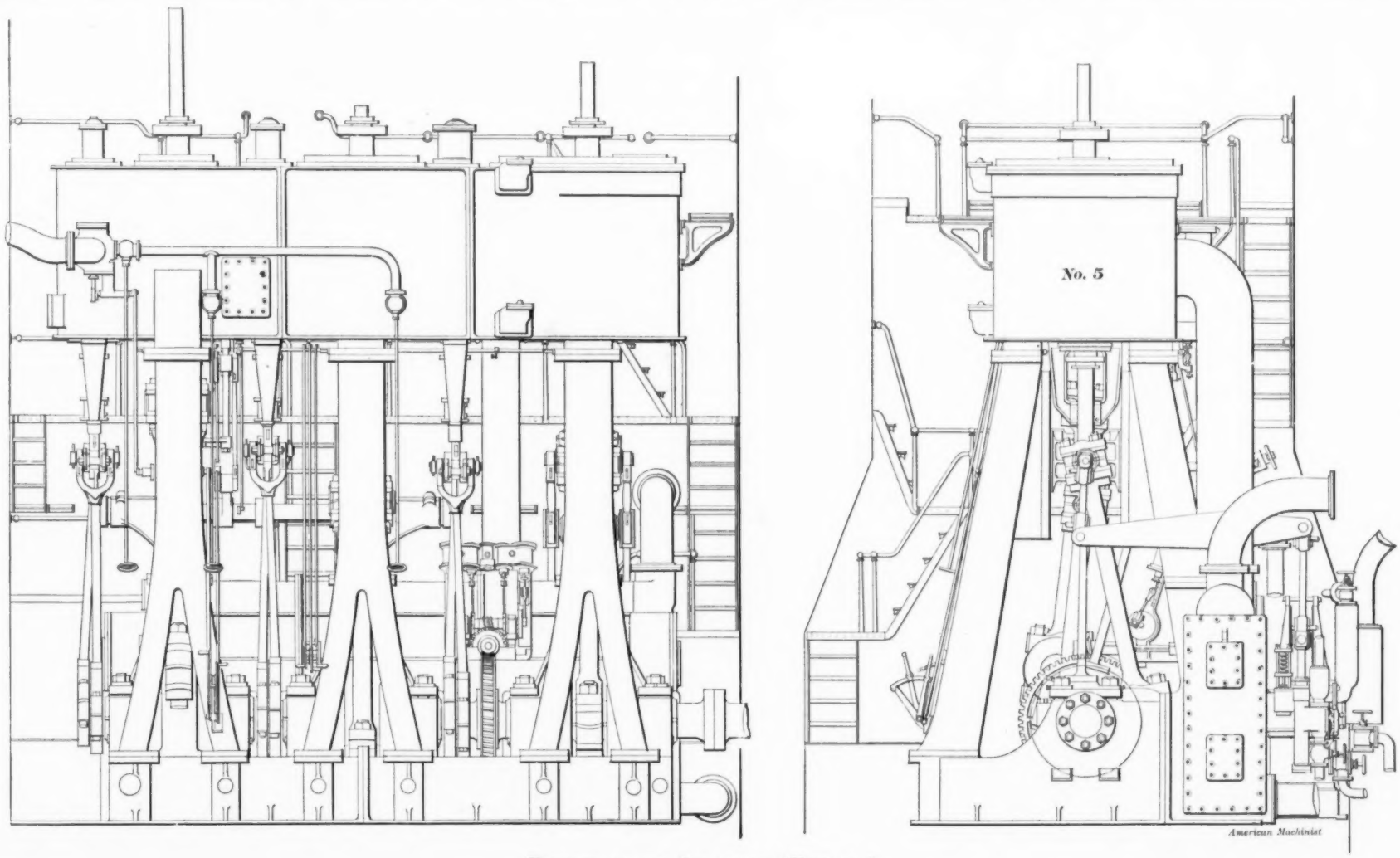


Fig. 2



Engines of the Steamship "Howard."

A Joke On the Engineer.

On the "Reading" road they are trying one of the Wooten-Vauclaine compounds with the side-rods off—using only one pair of drivers on fast passenger service. The engineer says she does very well that way with a light train, but is sometimes a little slow getting away from a station. There is a device on the engine for blowing sand

under the drivers when it is wanted to prevent slipping, and the air for this is taken from the air-brake service. It works beautifully, so far as applying the sand is concerned, but every time it is used the escape of air puts the brakes on.

LETTERS FROM PRACTICAL MEN.

Why Does a Bicycle Stand Up?

Editor American Machinist:

I have as yet seen no reason for changing my views on this subject, as expressed in your issue of November 15th, last; the facts, as before, seeming to me to be that the machine in question stands up because its lower parts are continually being brought underneath its upper parts, mainly by the action of the rider, either voluntarily or involuntarily.

Mr. Begtrup, in the November 29th issue, admits the action which I claim, but thinks that the "main point" is not involved therein. He speaks of a wheel standing up because that is its "natural" position, and because it is in "stable equilibrium" and "steady balance!" He does not tell exactly *why* it does this, but we may reasonably suppose that modern bicycles must be akin to Dr. Watts' little pups, which delight to bark and bite because "'tis their nature to."

His comparison of the action of a running wheel with a pendulum, does not seem to me quite luminous, as the pendulum obviously regains its vertical position in a very different manner from the alleged action of the boy's hoop. As far as I can recollect, my chief trouble used to be to keep the hoop up—and certainly was not in keeping it down.

Mr. Begtrup's explanation of why a disk rolling upon a plane has a tendency to go straight ahead when perpendicular thereto, and to follow a curve when inclined to such perpendicular, is probably correct, although it is not quite clear what he means by saying that a slight impression made in the plane in question is an "increment" of the track of the wheel. The fact is that the vertical disk in question may be regarded as a cylinder which would naturally roll straight ahead, because there is nothing to change its course, while an inclined disk may be considered as a truncated cone, which would obviously roll around the point where its projected axis struck the plane upon which it is rolling, this point being, of course, the apex of the cone. To do this it is not necessary that an actual "impression" should be made, although in reality this is in some degree the case. Not to go into a mathematical explanation of this phenomenon (and considering the plane in question as a level floor), it is enough to say that with the vertical disk each down-coming particle which is about to strike the floor lies in a vertical plane, which marks the immediately future course of the disk. With the inclined disk, on the contrary, each down-coming particle lies off to one side of a straight-ahead course, and thus gives a series of lateral deflections which produce the curved path in question. Anyone may illustrate this by rolling a silver dollar vertically, and then by holding it down nearly flat upon the table. In the latter case the curve it tries to follow is evidently a compromise between a straight line and the curve representing the periphery of the dollar, and the flatter it is laid down the nearer its course will approach the latter.

It seems to me that the principal flaw in Mr. Begtrup's argument lies in his assumption that when the wheel has commenced to tip sidewise, and the curved path which we both agree upon (at any rate when the front wheel has been turned out of the plane of the rear wheel) has commenced, the *rider* is continuing his course in a straight line, and that therefore his underpinning will be restored by the lateral motion caused by the curve in question. This, however, is not the case, as the rider is no longer traveling straight ahead, but in a direction governed by the two component motions in question, the former straight-ahead one, and the tipping-sidewise one, the result of which is evidently a curve to one side. This, the curve upon the ground may or may not be able to keep pace with—or rather keep beneath. It must be admitted that the whole set of motions involved are somewhat intricate, and that the primal steering action which seems to me the chief factor in the balancing, may be somewhat modified by various other conditions—this being but slightly the case, however, as I view it.

Mr. Begtrup further compares the balancing of a bicycle with a skater. Speaking of the case of sliding along on one skate, and the difficulty of standing still upon the same, he seems to attribute this to some mysterious virtue inherent to a *state of motion*, ignoring the fact that all motion is only relative, and that the skater who appears to him to be moving might really be standing still, when regarded from some zero point in space, but whose performance would go on all the same. For practical purposes the possibility in question could be demonstrated by the skater standing still while the piece of ice was made to slide under him at the proper speed. Does anyone imagine that under such conditions he could stand up any better than he could on stationary ice, unless, like Mrs. Dombey, he were to "make an effort" of some sort?

As a matter of fact this effort would, it seems to me, consist in slightly twisting his foot about a vertical axis or slightly leaning it about a horizontal one, either of which, or a combination of which, would, with the curved skate runner in common use, produce precisely the effect that I claim is obtained with a bicycle, viz., the working over sidewise in either direction to just the right amount, or a little more, of the line of support. This tends to continually bring it underneath the center of gravity.

Mr. Halsey, under date of December 6th, presents a "neater way of looking at" the question. In well-chosen language he advances the most logical arguments, which, by the way, agree in general with some of those of Mr. Begtrup, but which have one slight flaw, viz., an extremely doubtful premise. Abstracted, his line of reasoning is somewhat as follows: 1st. A child's hoop when started rolling will stand up, and will not lie down, and when pulled down a little way by the inexorable force of gravity, or from a down stroke by the child, will jump up, and, in general, come up smiling every time. 2d. A bicycle resembles a child's hoop. 3d. Therefore a bicycle will stay up, at any rate, under the majority of adverse circumstances.

The argument regarding the compensating action of gravity and centrifugal force, with the effect of a hoop being constantly restored to its vertical position, is a very pretty one, beautiful enough indeed to be true, but, unfortunately, "not proven." If it is true, and proven, why do the little boys chasing hoops vie so with each other in keeping up with them, and in skillfully striking them sidewise to maintain their equilibrium, and why, when I try to roll a dollar across the floor at a moderate speed, is it almost sure to hide itself under the nearest lounge or book case? It is, of coure, true that a wheel started off at a high speed, or started down hill with a self-accelerating speed, will often stay up for a considerable time. This is, no doubt, due, to a great extent, to the tendency of a wheel to maintain its plane of rotation, as in the gyroscope. The stored energy available for this purpose in the rim of the wheel, if heavy, and traveling at a high velocity, must, of course, be much greater than in a light object revolving more slowly.

If, however, I am wrong, and if any rolling wheel *will* right itself (save under occasional circumstances where the centrifugal force does happen to balance the accidental curvature which the surface of the ground at that particular point has chanced to make it take) then the fact ought to be demonstrated, both mathematically and by well authenticated experiments, that those of us who are groping somewhat in the dark may clarify our theories, and that we may all agree in regard to bicycles.

Mr. MacIntosh, in the December 20th issue, does not make his theory very clear, but it seems to hang upon the fact that the rider of a bicycle, like a projectile, is trying to travel in a straight horizontal line. This is true, but gravity is trying to pull him straight down, just the same as it does a cannon ball. When, however, a strut-like lever, consisting in this case of the bicycle itself, is interposed between him and the ground, at a certain angle with the vertical, as is the case after tipping has commenced, either a rider or a cannon ball will commence to deflect sidewise, being guided by the swinging lever. The question is how to get the lever vertical again, so as to accommodate itself to the new course which the projectile has taken. This, I think, has been provided for by the explanation in my original article.

Mr. Chappell, also under the date of December 20th, has put it out of my power to discuss the main question with him, by kindly agreeing with me all through, and, therefore, as a matter of course, I can but think him a most sensible essayist. He does not, however, quite understand me in what I say regarding an acrobat. I did not refer particularly to a slack rope walker, whose work seems to be somewhat different from the acrobats I had in mind, who can sit upon a stationary bicycle or stand upon the top of a ladder. These are both rigid objects whose maintenance in a vertical position requires very nice skill in pure balancing. A slack rope is entirely different in principle, and is apparently somewhat analogous to a bicycle, from the fact that it can be moved sidewise to bring the support under the center of gravity, at any rate for the time being, until it settles to its eventual lowest position.

The remarks of Mr. Chappell in regard to a high machine being more easily balanced than a low one, are undoubtedly true, and are in the line of the doctrine advanced by me, to the effect that gravity has, under such conditions, to work for a longer time in its fight against inertia to get a given amount of lateral tip. This additional amount of time available enables the rider more easily to steer his wheel under the desired point.

Under date of January 17th, Mr. Begtrup again writes, but does not seem to be quite so sure as before about the principle of a curved track made by an inclined wheel applying fully to a two-wheeled machine, although he still seems to have the same faith in regard to a single wheel maintaining its uprightness.

The "unicycle," of which he gives a picture, seems to be very much like the old high wheel or "ordinary" bicycle, except in the arrangement of the joints of the steering apparatus, and also in the rider being somewhat further forward in the matter of legs, although upon some of the "ordinaries" his center of gravity was almost exactly over the axis of the front wheel, as is evidenced by such a rider frequently allowing the small rear wheel to rise from the ground for a considerable distance.

The feature of a safety guard wheel in front I have often thought would be a good one, and nothing but the monopoly of it upon butchers' hand-carts and the absence of it on the machines to be bought in the market, with my consequent dread of headers, prevented me from becoming a high-bicyclist.

Some years ago I made a sketch of a real unicycle with the rider over the wheel axis, and the pedals below it, the frame extending nearly to the ground both in front and behind, and then curling up, somewhat after the manner of a skate runner—these being merely safety guards to prevent possible "headers" and "tailers." There is no doubt but what such a machine might be ridden by an expert in its use by his learning to carefully proportion the amount of impulse given his body either in a forward or backward direction by the relative pressure upon the pedals when in their forward and rear positions. Probably at a fairly high speed this trained manipulation, or rather *pediculation*, so to speak, in connection with the fact that the rider's own body, acting as a projectile, would rather than not maintain its constant speed, would enable riding of this sort to be successfully done. Possibly, moreover, the principle of a leaning wheel trying to make a curved track, in connection with the power which the rider would have to throw himself sidewise and thus add to or subtract from the centrifugal force available, using the inertia of the machine as his abutment, might be the key to the steering and balancing operations. All of this, however, is but guesswork, to solve which a practical trial with such a machine would be of great interest.

Under the same date as above, Mr. Norris (whom, by the way, I can personally vouch for as a rider of great skill who is well versed in single wheel riding, and in practicing various ingenious feats, both on and off a moving machine) writes to the effect that, like a broomstick, a bicycle would rather lie down than stand up, which doctrine I fully agree with.

The rest of his argument seems to be mainly the statement in general terms of the principles for which I have been contending, viz., that at slow speeds the balancing action consists of getting the base under the center of gravity, mostly by the wheeling over of the front wheel into the proper position by means of turning it to a suitable angle and taking advantage of the forward motion of the machine already acquired; also that it further consists of a general tendency of bodies to continue their motion in the line in which they are started; and that, in revolving bodies, this influence becomes more and more potent as the speed is increased. There is, however, no definite line of demarkation which would separate the different theories or different sets of conditions, as he, in his last paragraph, would seem to intimate. At a low speed certain conditions may preponderate, and at a high speed other conditions may, but the gradations between must obviously be through a series of steps infinite in number. Oberlin Smith.

The Proper Method of Projection.

Editor American Machinist:

Regarding the proper method of projection as applied to working drawings, it is reasonable to assume that any method is proper, if by the use of that method the object of the drawing is best attained. The machine-shop drawing is simply a memorandum showing what is to be produced. It is necessarily an illustrated memorandum, and to be perfect it should answer all questions which a workman can reasonably ask in regard to the work.

A drawing which may be clear to the draftsman may be misunderstood by the workman or, it is possible, may require much explanation. In this respect it is not a proper drawing, and the method employed is faulty. Of the two methods ordinarily used for shop drawings, it would seem that the more logical is the third-angle method. Probably, for most work, it makes no great difference which system is used, as far as clearness of expression is concerned, but occasionally a piece is required to be shown, which, if placed in the first angle, is difficult to comprehend, whereas, if drawn in the third angle, experience has shown that the drawing is perfectly understood. This, it seems to me, is the strongest argument which can be presented in favor of the third-angle method, *i. e.*, that drawings made by this system are more readily comprehended by the workman. Nor should it require further argument. The very fact that most of our leading machine shops use this system in their every-day work is sufficient reason why our technical schools should conform to it in their machine drawing.

The disposition of the views in the third-angle method accords with one's inherent ideas of rightness, and can lead to no error, for the position of the drawing shows the view taken—the front view is what you would see in looking at the front of an object, the top view is at the top of this view, the right-end view is placed at the right, and the left-hand view at the left of the front view. With the duplication of drawings, which has arisen since the intro-

duction of blue printing in our drafting rooms, the workman has had a greater opportunity to interpret drawings than formerly, and the defects of the old descriptive geometry system, which was formerly in vogue, have been made apparent. Thus it is that the first-angle method has been entirely dropped in many shops, and used only occasionally in others, while the third-angle, or natural shop method, has continued to grow in favor among practical men.

While either method or combination of methods, with any particular piece, or machine, may show equally well what is wanted, it is better that one system be used throughout the shop. As Mr. Thorne expresses it (and no one is better qualified): "Individual draftsmen and shops will always have their local styles and prejudices, which they will claim work better for them than anything else, but large engineering establishments, in which the harmony of the various departments must be maintained, and in which various details are completed by different gangs, under different foremen, cannot succeed without a perfectly consistent system of drawings that permits of no doubt as to the meaning, and which does not require the constant service of an expert interpreter." From the various letters that have appeared in the discussion of this subject, there seems to be a general unanimity of opinion that the first-angle method is the one usually adopted in teaching mechanical drawing in our technical schools and colleges.

While the first angle is generally used in teaching descriptive geometry, many instructors use the third angle for this subject; and although there are a few technical schools which adhere to the old system, yet, as far as the mechanical engineering courses are concerned, the third-angle method is almost universally preferred and used for work in machine drawing. Among the leading colleges which use this system are the following:

Sheffield Scientific School (Yale).
Columbia College School of Mines.
Lehigh University.
University of West Virginia.
Tufts College.
Worcester Polytechnic Institute.
Maine State College.
Iowa Agricultural and Mechanical College.
University of Pennsylvania.
Purdue University.
Stevens Institute of Technology.
Cornell University.
University of Minnesota.
University of Illinois.
Michigan Agricultural and Mechanical College.
Rose Polytechnic Institute.
Georgia School of Technology.
Case School of Applied Science.
University of Virginia.

When we consider further its very general adoption in the leading engineering works of the country, it would seem that the advocates of the first-angle method of projection would recognize the importance of conforming to the more general shop practice.

Teaching a system which is liable to place the young draftsman at a disadvantage when he enters a drawing room is especially to be deplored. J. J. Flather.

Purdue University, Lafayette, Ind.

American vs. English Lathes.

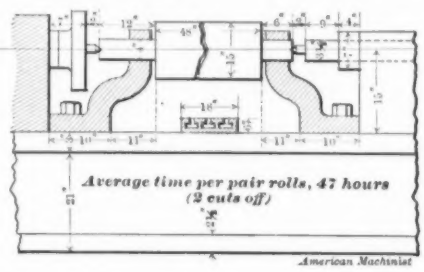
Editor American Machinist:

In a recently published letter, Mr. John E. Sweet says: "The same tool that would cut iron at forty feet a minute in the English lathe could not be made to cut the iron in the American lathe, of the same size, at all, at any speed."

I inclose a sketch, torn from my note-book, of an English lathe, with a job of roll turning in it, made some 12 years ago from measurements taken as the lathe was at work. This lathe was built specially for the job, and was very heavy. It was in use in a shop employing more than 500 hands; one special branch of their work being machinery in which hard rolls formed an important factor. As these rolls, however hard, got out of face frequently, much returning was necessary, hence the special lathe.

The English owner of the English shop in which this English lathe was at work, told me that the lathe would re-turn two of these rolls in 47 hours, as an average, taking two cuts from each. He explained the slow time as being due to the hardness of the iron, which, he said, was as hard as he could make it. Just then, and for years before, similar rolls, 14 inches diameter by 48 inches face, were being re-turned in America, in a 24-inch New England lathe, built on New England lines, and mighty slim lines at that, by an Englishman, who had learned his trade at 'ome, don't you know, but who happened then to be under American direction, at the rate of 16 in 47 hours!!!

Whether those American rolls were hard or soft, I will not venture to say now, but the specification to the foundryman was that the 2½-inch diameter runner, through which they were poured, *must* be white clear through. The core being 4¼ inches diameter, the metal in the roll would be 5 inches thick, and your foundry readers can guess about the probable hardness of 5-inch metal



when 2½-inch metal ran white. The speed at which the American rolls were turned never exceeded ⅛ of 40 feet per minute, and no steel I ever saw would have stood to cut them, whatever the make of lathe, at ½ of 40 feet per minute.

I made this sketch, not to profit by the example, but just to have a record of the "excessively ingenious way" (and this is English, too, don't you know) in which the "dog leg" supports for the journals were arranged so as to find room for the saddle. The tool post (not shown) was, as I recollect, a compound affair, movable from one T-slot to another.

If Professor Sweet has not erred in the above statement, the English engineer has made such progress in the last 12 years as to leave us as far behind him in the engineering race, as we always have been behind him in national feeling. I may want to say something more about this phase of the matter by and by.

A. B. Lawther.

Disappearance of a Machinist.

Editor American Machinist:

On the 5th of March a man came to my shop in need, and begged for work. I gave him a test job, and found him to be a first-class hand. I was, however, unable to employ him owing to want of work; but as he was to all appearances deserving, I gave him help, with the promise of work should anything come in. I also supplied him with a little money so that he might go to Philadelphia to look for work elsewhere. To make a long story short, I finally acquired such confidence in him that I trusted him with $12.50 to buy some goods for me in Philadelphia, since then he has not been seen.

He gave his name as H. Bensen, and was stout built, about 5 feet 6 inches, spoke with strong German accent, had a round head, fresh complexion, was well dressed, white shirt and collar, blue chinchilla reefer, black crush felt hat, said he had worked for Bliss & Co., as die maker, also as die maker in Baltimore can factories. Had good references, if genuine, said he was a Free Mason, and wore the badge on a small blue enameled slipper scarf pin; also Odd Fellow's badge on lapel of vest; said he was well known among Masons in Baltimore and Jersey City. I do not know the cause of his disappearance, and do not publish this with the idea of accusing him of dishonesty—since an accident of some kind might have happened him, but I would be glad to have any information about the man, and think this is probably the best plan for getting it. E. A. Suverkrof,

General Machinist.

619 N. 5th Street, Camden, N. J.

A Correction—Hot Water Freezing—Card Index System—Proper Method of Projection.

Editor American Machinist:

In my article on "The Diagram of a Corliss Valve Motion," in the American Machinist of March 14th, the engraver has substituted an *N* for an *H*, in the upper left-hand corner of Fig. 1, thus making two points marked *N*, instead of one only. In the text, an *O* has several times been used instead of a cipher, but this will probably cause little trouble in understanding the references to the figures.

I would suggest to Mr. Frank Richards that his hot water pipes freeze sooner than the cold water pipes because the dissolved air has been driven off the water by heating, while the water which has not been heated carries the usual amount of air in solution. This, I think, would affect the freezing of absolutely still water like that in a closed pipe, so as to produce the result noted.

Probably many more men would adopt the card-catalog idea for keeping track of the formulæ and bits of information which soon fill an ordinary note-book to overflowing, if all would give a little thought to the convenience of this method. My card "note-book" is contained in a tin tobacco box; the cards are 2¾x4¼ inches, and the outfit cost forty cents. Anything of interest, on any subject, that can be copied or pasted on a card, is kept in its proper place for all time, and the convenience of being able to find anything in its proper place alphabetically, is inestimable.

As for the methods of arranging views on a drawing, the only large shop using the first-angle method, with which I am familiar, was one whose first chief draftsman was a European, and the method has held its own to save confusion in changing. I could add several large concerns to Mr. Hund's lists of those employing the third-angle method. And it is not at all the case that the technical schools *as a class* are teaching the first-angle method; the Yale Scientific School, for one, has always taught the third-angle system, so far as I know, and I am very sure that all the larger schools are doing the same.

Sterling H. Bunnell.

Minneapolis, Minn.

Professional Inventors.

Editor American Machinist:

It appears to me that the logical outcome of your argument is, no man ought to attempt to do a thing unless he knows beforehand that he can do it. It seems to ignore the fact that all wisdom is the product of experience, and that we acquire no inconsiderable part of our wisdom from our failures. Most of us would be afflicted with too much swell at the top if we never made mistakes. It has been said that poets are born, not made; it is just as true as to any other calling. If none but born poets were permitted to write verse the world might be relieved. If none but inventors were permitted to invent or try to, time might be economized, but valuable experiences would be lost. The truth is, social progress is a product of emulation. Someone distinguishes himself and others desire to emulate his example. The world then advances, and though some may suffer, the happiness of the mass is promoted.

As a matter of fact, no one knows until he tries whether he can invent or not, and it may be that he will strike a lucky combination as well as his neighbor.

The necessary union of financial expertness and inventive ability to secure success, is not at all to the point. It has not pleased the Creator to combine these qualities in the same individual very often, proves nothing against the effort to invent. Mr. Hubbard could not invent a telephone, but he could organize a company, and the man who could invent the telephone may have been unequal to the organization of a company. But what of that—Patti can sing, but she must have a manager, and whether he can sing a note or not is immaterial. The truth is we have, by striving, developed in this country a race of inventors, and thousands of them are professional inventors. They may not as a rule earn so much money as "estimators," but it may be taken as quite certain that men by taking thought cannot make of themselves this or that, unless nature has endowed them with the requisite mentality. The good estimators would probably never become good inventors, and in like way the man who has an inventive brain, probably would not learn to be a good estimator.

It is very fortunate for the world that men are so differently endowed, and probably it is equally fortunate that there are few who have mentality to compel success.

R. D. O. Smith.

Handy Rules.

Editor American Machinist:

A few rules which the writer has found very convenient for rapid work and are easily remembered are given with the hope that someone else may be benefited.

I have never seen any of them in print so they may be new to some:

To find the number of gallons of water in a cylindrical pipe or tank, or its capacity in gallons:

$$d^2 \times L \times .04 \text{ or } \frac{d^2 \times L \times 4}{100} = \text{gallons.}$$

Add 2 per cent. to the result and it will be almost precisely exact.

d = diam. in inches, L = length in feet.

To find the approximate area of a circle: Square the diameter, take three-fourths of the product and add 5 per cent. to it, or $\frac{3}{4} d^2 + 5$ per cent. This gives a result slightly greater than one-fourth of one per cent. too large.

To find the square of a number when the one next to it is known: From the known square subtract (or add as the case may be) the sum of the two numbers. For example, wanted, square of 51.

$(50)^2 = 2{,}500$, $(51)^2 = 2{,}500 + (50 + 51) = 2{,}601$. Or, wanted, square of 49.

$(50)^2 = 2{,}500$, $49^2 = 2{,}500 - (50 + 49) = 2{,}401$.

If one number intervenes add or subtract four times the intervening number.

Example—Wanted, square of 68.

$(70)^2 = 4{,}900$, $(68)^2 = 4{,}900 - (69 \times 4) = 4{,}624$. Wanted, square of 32.

$(30)^2 = 900$, $(32)^2 = 900 + (31 \times 4) = 1{,}024$.

These rules are handy because they facilitate mental work. The first, while being very accurate, is exceedingly simple, and the quickest way I know of getting the contents of a cylindrical vessel in gallons.

Fred. W. Richart.

One of the most absurd things that have come to our notice recently is a trotting sulky, which incloses and covers the horse, so to speak; the wheels (pneumatic tired wheels), being placed, one at each side of the horse, and the driver's seat above the horse, but somewhat to the rear of the wheels; it being claimed that, being thus placed, the weight of the driver will tend to push the horse forward, and he will have nothing to do but to keep out of the sulky's way, so to speak. It must be obvious that the same principle applied to vessels or to railroad trains should make their own cargoes furnish the motive power, and thus the steam engine would be once more entirely superseded. And to think that such a thing should emanate from Connecticut, where every other man you meet is an intelligent and shrewd mechanic!

It is reported that all the mechanics employed by the Baltimore & Ohio Railroad were put on piecework April 1st.

AMERICAN MACHINIST

Communications relating to the reading columns should be addressed to the Editor. All other communications should be addressed:

AMERICAN MACHINIST,
203 BROADWAY, NEW YORK.

PUBLISHED WEEKLY AT
203 Broadway, New York.

Horace B. Miller, Pres't and Bus. Manager.
Charles W. Biglow, Treas. and Sec'y.

Fred J. Miller, Editor and Mechanical Engineer.
J. G. A. Meyer, } Associate Editors
Chas. M. Jones, } and Mechanical Engineers.

Special Announcements.

☞ *Positively we will neither publish anything in our reading columns for pay or in consideration of advertising patronage. Those who wish to recommend their wares to our readers can do so as fully as they choose in our advertising columns, but our editorial opinions are not for sale.*

☞ *Every correspondent, in order to insure attention, should give his full name and address, not for publication, but as a guarantee of good faith.*

☞ *We are not engaged in procuring patent rights, or in selling machinery, nor have we any pet scheme to advance, or hobby to ride.*

☞ *We invite correspondence from practical machinists, engineers, inventors, draftsmen, and all those specially interested in the occupations we represent, on subjects pertaining to machinery.*

☞ *Subscribers can have the mailing address of their paper changed as often as they desire. Send both old and new addresses. Those who fail to receive their papers promptly will please notify us at once. Date on wrapper denotes week with which subscription expires.*

Subscription.

$3.00 a year in advance, postage prepaid, in the United States, Canada, and Mexico.
$4.00 a year to Other Countries, postage prepaid.

Advertising.

Transient, 35c. per line, each insertion.
"Business Specials," 50c. a line.
No Commission allowed to Advertising Agents.

The American News Company,

Publishers' Agents, New York.
DEALERS SUPPLIED BY
The Albany News Company, Albany, N. Y.
The American News Company, New York, N. Y.
The Baltimore News Company, Baltimore, Md.
The Brooklyn News Company, Brooklyn, N. Y.
The Buffalo News Co., Buffalo, N. Y.
The Central News Company, Philadelphia, Pa.
The Cincinnati News Company, Cincinnati, Ohio.
The Cleveland News Company, Cleveland, Ohio.
The Colorado News Company, Denver, Colorado.
The Detroit News Company, Detroit, Mich.
The International News Company, New York, N. Y.
The Minnesota News Company, St. Paul, Minn.
The Montreal News Company, Montreal, Canada.
The National News Company, New York, N. Y.
The Newark News Company, Newark, N. J.
The New England News Company, Boston, Mass.
The New Orleans News Company, New Orleans, La.
The New York News Company, New York, N. Y.
The Northern News Company, Troy, New York.
The Omaha News Company, Omaha, Neb.
The Pittsburgh News Company, Pittsburgh, Pa.
The Rhode Island News Company, Providence, R. I.
The San Francisco News Co., San Francisco, Cal.
The South West News Company, Kansas City, Mo.
The St. Louis News Company, St. Louis, Mo.
The Toronto News Co., Toronto, Ontario, Canada.
The Union News Company, New York, N. Y.
The Washington News Company, Washington, D. C.
The Western News Company, Chicago, Ill.
The Williamsburgh News Co., Brooklyn, E. D., N. Y.
The Wisconsin News Company, Milwaukee, Wis.

The International News Company, Bream's Bldg's, Chancery Lane, London, E. C. Eng., or Stefanstrasse 18, Leipzig, Germany, will receive subscriptions for the American Machinist, at 16/6 per annum, English currency, or 17 marks per annum, German currency, postpaid.
Subscriptions received in Paris, France, by E. Terquem, 31 Boulevard Hausmann, at 21 francs per annum, postpaid.

Subscriptions received in Australia by W. Williams, 17 and 21 Fink's Buildings, Melbourne.

NEW YORK, APRIL 11, 1895.

CONTENTS.

PAGE.
The Cornell Dividing Engine. By Geo. F. Ballou..... 281
Two-spindle Milling Machine..... 283
An Oil Can Filler..... 283
An Example of Co-operative Contract and Piecework. By M. Cokely..... 283
New Throttling Compound Engine..... 284
The Immortal Keely..... 284
The Lunkenheimer "Jewel" Grease Cup..... 284
Rolling Mill for Sheet Metals..... 284
Engines of the Steamship "Howard"..... 285
A Joke on the Engineer..... 285
Letters from Practical Men: Why Does a Bicycle Stand Up? By Oberlin Smith....The Proper Method of Projection. By J. J. Flather ...American *vs.* English Lathes. By A. B. Lawther....Disappearance of a Machinist. By E. A. Suverkrof ...A Correction—Hot Water Freezing—Card Index System—Proper Method of Projection. By Sterling H. Bunnell....Professional Inventors. By R. D. O. Smith....Handy Rules. By Fred. W. Richart..... 286, 287
American *vs.* English Lathes..... 288
Electrical Engineering..... 288
We Employ No Reporters..... 288
Questions and Answers..... 289
Frederick E. Sickels and His Cut-off. By W. F. Durfee..... 289
Initial Increase of Entropy, and Thermal Lag, in Steam Machinery. By Charles M. Jones... 290
Heating, Forging and Hardening Steel. By "Quirk"..... 291
No Engineer Wanted. By W. H. Wakeman.... 291
A Novel Planer Chuck..... 292
New Catalogs..... 292
Manufactures..... 292
Machinists' Supplies and Iron..... 293

American vs. English Lathes.

Professor Sweet's letter, published on page 166 of this volume, in which he made comparisons between American and English lathes, not favorable to the former, seems likely to stir up quite a discussion in our columns, and its effects are quite apparent also in the English technical press, where conclusions (and much comfort) are being drawn from it that are unwarranted in our opinion.

The department of "Letters from Practical Men," in this paper, is practically an open forum, in which anyone who has anything to say about machinery, that is of interest, can have the opportunity of saying it, regardless of whether his opinions or experience agree with ours or not. It is only by free discussion that truth is arrived at. We publish many letters in which opinions differing from our own are expressed, and the letter referred to above is one of them. We do not think that the English lathe is, *per se*, better than the American lathe, but on the contrary, that if either one, considered by itself, and without reference to the particular manner in which it is to be handled, is better than the other, it is most decidedly the American lathe. Professor Sweet's probable answer to this would be that we are amongst those American machinists he mentions who have never had the least experience with the English lathe, and are therefore not competent to express an opinion regarding comparative merits.

This may be true enough, but nevertheless our opinion is supported by a number of machinists who have had experience with both kinds of lathes, and some of these machinists are Englishmen who have no hesitation in saying that the American lathe is far superior. We have known very many English mechanics working in machine shops in this country, and have yet to hear of the first one who wished to exchange his American lathe for an English one. On the contrary, most of them freely say that they do more work here than they did at home, and that the superiority of the American lathes and other machine tools is partly responsible for the increased power to produce work.

It seems to us that the principle of adapting means to ends should apply in lathe building as in all other things. If the true conception of a lathe is a machine to remove surplus stock from a forging or casting, then perhaps it should be made as strong and stiff as possible, without much regard to convenience, or what we call handiness. But we do not think this expresses the real function that most lathes have to perform most of the time—at least in this country. They have to make things true and smooth, and have to be so arranged and proportioned as to make them easy to handle and convenient for the operator. We may theorize and apply the principles of high art to lathe design as much as we choose, but lathes are judged, and always will be, by the men who wear overalls and aprons and operate the lathes. No matter what other merits a lathe may possess, it must please the man who is to run it or it cannot be successful, and we feel quite sure that no lathe has ever been made that suits the men who run it nearly so well as the best American lathe, whose design and development are due to these same men—the men who do lathe work and who know what kind of a tool they want to do it with.

A prominent tool builder, who is quoted as having said "that no one ought to expect a 16-inch lathe to turn a 16-inch pulley," was right in our opinion, provided he meant, as we suppose he did, only that such a lathe should not be expected to turn 16-inch pulleys economically. There are pulley mills for such work where it must be done as a regular thing, and where only an occasional 16-inch pulley must be turned in a 16-inch lathe, it is far better to be satisfied with an expensive pulley than to sacrifice convenience and rapidity of handling on the other 99 per cent. of the work for the sake of having a lathe that will compete with the pulley mill on the occasional pulley.

It is a fact, on record in our own and in the columns of our foreign contemporaries, as well as in the sales books of our tool builders, that American lathes and other tools are going abroad in increasing numbers—not merely to be tried and laid aside, but to be used; and at least one English concern is building a lathe which is called, and is essentially, an American design—presumably because they have found a demand for such lathes in their market.

There are some poor lathes made in America, as we all know, and undoubtedly some of them are sent to other countries where they discredit American lathe builders, for, unfortunately, business activity and push is not always combined with the mechanical ability and good judgment required to build a good lathe. On the other hand, good lathes—lathes well adapted to the service required of them are built in England, France, Germany and other countries, but we have the word of more than one English-bred mechanic to the effect that the best English lathes do not compare well with the best American ones, and we think this opinion is based rather upon conviction in the face of facts of experience, than upon prejudice against the lathes of their own country or in favor of ours.

Electrical Engineering.

An esteemed contemporary, devoted to the "subtle fluid," in commenting upon the building of electrical railways, states that it is but recently that construction has been considered as of sufficient importance to be classed as engineering; that the prevailing idea has been that the building of a proper line was a mere matter of good material.

The suffering capitalist whose dreams of golden reward for trifling outlay have been rudely dispelled by the dire failure of some scheme, that—thanks to the glowing promises of the irrepressible "electrical expert"—he has invested in, will derive small comfort from the above confession as to the "why so" of his loss, coming as it does at this late day, but posterity, at least, will have reason to be thankful that the true reason for so much disreputable work has at last been acknowledged by the special champions of the dynamo, for the admission of error usually precedes the abandonment of sin.

When the one or two competent electricians who existed a few years ago, demonstrated that electric lighting and powering were practical successes, an Oklahoma boom ensued, and a horde of incompetents sprang into the arena, eager to seize the plums that, even the most obtuse could scarcely fail to see, hung waiting to be plucked.

Glowing prospectuses abounded, setting forth the merits of this, that, and the other "system," that had been perfected (?) and that was to revolutionize illumination and power transmission, and when the unsuspecting capitalist took the bait, he too often found himself with a few half-worked-out elementary details on his hands, and minus the happy electrician—who had slipped out of the scheme and gone to conquer new worlds with similar systems.

As few designers, skilled in perfecting mechanical details, had at that time any particular acquaintance with electrical principles, the unfortunates who found themselves with a half-worked-out railway, or other scheme, on their hands, were often induced to turn over the constructive branches to some individual whose handiness as a twister of wire, and a juggler of the soldering iron, seemed to qualify him as a director of the mechanical work.

As a consequence the country became gridironed with worthless lighting and railway lines, and it was not until the reputable concerns had been running long enough to educate employes in the details of successful construction that the innumerable wild-cat plants found it possible to get upon a paying basis; which the majority of them have done by securing, from the reliable concerns, the services of men acquainted with the practical side of the profession.

The notion that engineering consists in holding down a luxuriously upholstered chair, and issuing formula and essay matter through the medium of a phonograph or stenographer, has been again demonstrated to be wrong, as has also the notion that a student graduated from a school in which the time limit made it impossible for him to acquire more than the merest smattering of his profession, can immediately be trusted with important constructive work, or that there is nothing further for him to do except to fit up an office and await the call of some heavy corporation requiring a consulting expert.

It takes at least ten years of the hardest and most varied experience to make a really first-class draftsman, and the impression that anyone (however brilliant mentally he may be) can go a step higher, and set up as a full-fledged engineer, in from two to four years from the first plunge, is simply an hallucination.

We Employ No Reporters.

We have again heard of a man going about in the upper part of New York City claiming to be representing this paper as a "reporter," and asking questions of machine shop proprietors on the pretense of writing a history of machine industries. We take occasion to say again that we employ no such man; and we would be pleased to have someone to whom he may represent himself as our "reporter," take such action as will lead to an exposure of his scheme whatever it may be.

It is evident from recent court decisions in Chicago, Brooklyn and elsewhere that laws designed to limit the number of hours per day that men or women shall work for a private employer cannot be put in force; the Illinois court holding that personal liberty is unwarrantably infringed by such laws and that they are unconstitutional.

The personal liberty of women in Chicago to work an unlimited number of hours per day in sweat shops is a doubtful privilege to say the least, and the same may be said of the liberty of Brooklyn motormen to work long hours on trolley cars; but it is the principle involved that seems to be condemned by the judges, and, until constitutions are altered, as of course they can be by the vote of the people, or the competition between those who seek work becomes much less keen than it now is, sweat shop proprietors and trolley companies will be able to fix the hours of labor to or beyond the point of human endurance. We cannot escape the conviction that the public has a direct interest in this matter and should, therefore, in some way have a voice in it. Certainly there is a limit to the number of hours per day which it is safe to allow a motorman to drive an electric car through the crowded streets of a city, and the public should have the right to say that this limit shall not be passed.

One of the most satisfactory and at the same time indubitable proofs of the actual return of prosperity is the upward tendency of wages which has manifested itself, especially in the coke industries of Pennsylvania and the woolen manufacturing industries of New England. An especially gratifying feature of the situation is the fact that these advances have been voluntarily made by employers, and it is likely that others will be obliged to follow suit in order to retain their workmen. The fear, expressed by one of our contemporaries, that the increase of wages has been premature and not justified by the real condition of business will, we imagine, appear somewhat ridiculous in the eyes of those who have made the advances, but it is really only our esteemed contemporary's way of letting itself down easily after a rather prolonged attempt to show that wages could not again rise, but must in the nature of things continue to fall.

No other single feature of the industrial situation has so good an effect upon business generally as rising wages and increased employment.

It has been decided by a court in Connecticut that an insurance agent can use in the service of an insurance company knowledge gained while in the service of a rival company. This decision is in line with decisions covering the same principle with regard to industrial establishments; and any other decision, if final, would very much retard advance in industrial and technical knowledge, for no mechanic or engineer would then be at liberty to use his accumulated stock of experience when taking a new position; an idea which is seen to be absurd upon the face of it, and yet it has been contended for—unsuccessfully.

Questions and Answers.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet. We cannot undertake to answer questions in "next issue." This department is usually crowded, and questions must wait their turn to be answered. Neither can we undertake to solve mechanical or engineering problems, and send answers by mail.

(142) C. W., Willoughby, Ohio, asks: Is there any periodical published devoted to plumbing and steam fitting? If so, please give the names. *A.*—*Plumbers' Trade Journal*, 66 Beekman street; *Sanitary Plumber*, 78 Reade street; and *Engineering Record*, 277 Pearl street, all in New York City.

(143) A. R. G., Galt, Canada, asks: Could you give me the title of a book dealing with the manufacture of needles, one that gives the modern modes of making them? *A.*—We do not know of a book which treats on this subject. 2. Give title of a book which treats on gas engines, one which is up to date. *A.*—"The Gas Engine," by D. Clerk, is considered to be a good book.

(144) J. R., New Orleans, writes: Is there any alteration in the speed of a small engine —1½"x3"—running with full stroke in one case, and cutting off at ⅛ stroke in the other? *A.*—If the engine is under the action of a governor which actuates the cut-off to suit the load, there will be little, if any, difference in speed, but with a load varying with the speed and no governor, the close cut-off reduces the rotating velocity. If the engine has a single slide valve, it will be usually impossible to cut off much earlier than $\frac{7}{16}$ or ¼ stroke without distorting the other functions of the steam distribution.

(145) H. M., City, asks: Can an indicator motion be properly taken from the crank by means of a slotted lever or other such device? *A.*—A combination of levers and links can be made to give the proper motion theoretically, but practically the errors due to securing exact alignment, fitting, etc., would render such complicated mechanism worthless. An indicator is intended to move with the piston at all points of travel—unless for special purposes—and where the motion is not taken from the crosshead or its equivalent, there is always more or less uncertainty as to the correctness of the gear.

(146) J. J. L., New Haven, writes: I am building a compound engine of the following size: High-pressure cylinder, 1½ inches diameter; low-pressure cylinder, 3 inches diameter; stroke, 2½ inches; boiler pressure, 160 pounds; number of revolutions per minute, 250. What will be the horse-power of this engine? *A.*—Non-condensing, about one horse-power. 2. Will this engine drive a boat at the rate of 7 miles an hour? The dimensions of the boat are: Length, 21 feet; breadth, 5 feet; depth, 2 feet 4 inches. *A.*—The speed will depend much on the lines of the boat; on general principles, we should say that if the engine is run up to 400 revolutions per minute, it will drive the boat at the speed desired.

(147) The M. P. P. Co., St. Louis, write: We have a large number of iron patterns and are much troubled by their continued rusting when not in use. We have tried various plans to prevent this, but so far without success. Can you suggest a remedy? *A.*—We suppose you are familiar with the common method of finishing iron patterns, which consists in wetting their surfaces, after such finishing as is considered necessary and thereby coating them with rust. They are then heated and bees-wax melted over them and rubbed into the rust. Iron patterns treated in this way do not usually rust easily, if at all, and we know of no better method of preventing rust.

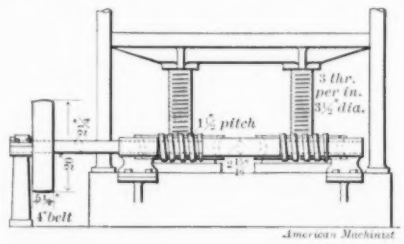
(148) J. P. T., Jackson, Mich., asks: Can excessive back pressure cause pounding in the driving boxes of a locomotive? Men frequently claim that increasing the size of the exhaust nozzle has stopped pounding. *A.*—Excessive back pressure will tend to cause pounding in the driving boxes, and since the exhaust nozzle will affect the back pressure, there may be cases in which pounding has been stopped by increasing the size of the exhaust nozzle. 2. How do you calculate the pressure tending to force out the mud ring of a locomotive? *A.*—Multiply the area of the surface of the ring which is exposed to the steam pressure by the pressure per square inch as indicated by the steam gauge; the result will be the total pressure tending to force the ring outward.

(149) X. Y. Z., Petaluma, Cal., asks: Which can burn the greatest amount of coal in a given time, an expert fireman or an amateur; that is, which can turn the most coal into smoke and gas regardless of heat produced? *A.*—A genuine fireman—if occasion required—could without doubt burn the greatest amount of fuel, but his pride would scarcely allow him to turn combustible into mere smoke and gas. He would force the fires, when called upon, to their utmost *useful* limit, but it would be hard to induce him to go beyond that point unless entered upon a mere competitive trial. An ambitious amateur can be depended upon to burn the most fuel for a given heating effect.

(150) D. N., ——, Wis., sends us a tracing of a cone pulley arranged for rope gearing; the diameter of the largest step is 11¼ inches, the shaft to which the cone pulley is attached is driven by pulley 6 inches diameter and 1⅝-inch face. He asks: Do you consider the pulley, of which I inclose a tracing, safe to run at a speed of 5,000 revolutions per minute; the pulley is to be made of cast-iron? *A.*—The speed of the circumference of the pulley should not exceed 6,000 feet per minute; since this speed will be exceeded when the pulley makes 5,000 revolutions per minute, we consider it to be not safe. 2. Will a 1¼-inch belt drive it at the above speed? A rope belt ¼-inch diameter is to run from the grooved cone pulley to a 1-inch pulley fastened to a spindle ¼-inch diameter. This machine is to be used for engraving purposes, diameter of cutters $\frac{1}{16}$ inch down to a needle point. *A.*—We believe that the belt is too narrow; for such speeds we should use a belt 1¾ inches wide.

(151) W. H. J., Brookville, Pa., writes: I have noticed in your columns a reference to the Chinese writing stick recommended for writing the dimensions on drawings. Can you enlighten my ignorance with regard to the article, or refer me to a dealer who can supply it? *A.*—You will find the Chinese writing stick illustrated in our issue of February 2, 1893. It is made of hard box wood; its outward form is like that of an ordinary lead pencil, and about equal in diameter. One end is sharpened to a conical form like an ordinary lead pencil, and brought to a sharp point; on the conical part a small channel or groove is cut for holding the ink; the stick is then used like an ordinary pen, and gives the same results as are obtained with a stylographic pen. The advantage claimed for the use of this stick is that all parts of figures or letters are of equal thickness, hence the liability of losing a part of a letter or figure in blue printing is not so great as when figures or letters have been written with a pen, which are liable to have thin and heavy parts, of which the thin parts are frequently lost in blue printing. You will have some difficulty in finding a dealer who can supply these sticks; you can, however, make one very easily.

(152) F. A. S., Nashua, N. H., writes: Kindly give me the method of computing the capacity of a press as per inclosed sketch. The worm wheel has 38 teeth. *A.*—We presume you wish to know what pressure this press can exert. The worm wheel having 38 teeth will make $\frac{1}{38}$ of a revolution, while the 20-inch pulley makes one revolution. Since there are 3 threads per inch on the screw, the load will move through a distance ⅓ of an inch for one



revolution of the screw, or through $\frac{1}{3} \times \frac{1}{38} = \frac{1}{114}$ inch while the screw makes $\frac{1}{38}$ of a revolution. Hence, during the time that the pulley makes 1 revolution the load will travel through a distance of $\frac{1}{114}$ inch. The circumference of the 20-inch pulley to which the force is applied is 62.83 inches, and assuming that the belt can exert a force 45 pounds per inch of width, then the total force applied at the circumference of the pulley will be 45 × 4 = 180 pounds, and during one revolution of the pulley an energy of 180 × 62.83 = 11,309.4 inch-pounds will be exerted. Now the work done, that is, the distance through which the load is moved, multiplied by the load or pressure, must be equal to 11,309.4 inch-pounds. We have seen that the distance through which the load moves while the pulley makes one revolution is $\frac{1}{114}$ inch, hence the pressure exerted by the two screws will be $11{,}309.4 \div \frac{1}{114} = 1{,}289{,}271.6$ pounds, provided there is no friction. About 70 per cent. of the energy will be required to overcome friction, leaving 30 per cent. for the useful work done, hence the pressure exerted will be $1{,}289{,}271.6 \times .30 = 386{,}781$ pounds, or 193 tons.

(153) J. H., Philadelphia, Pa., writes: I have a shaft supported at both ends, the distance between supports is 8 inches. Please give me a formula for computing the diameter of shaft to support a load of 15 tons; the shaft is to be made either of steel or iron. *A.*—If the load is applied at the center of the shaft, and the shaft is of wrought-iron, then its diameter is found by the following formula:

$$d = \sqrt[3]{\frac{W \times l}{4{,}700}}, \qquad (1)$$

in which W = load in pounds, l = length of span in inches, and d = diameter in inches. The above reads: Multiply the load in pounds by the length of span in inches, divide this product by 4,700, and find the cube root of the quotient, the result will be the diameter of the shaft in inches. Substituting for the letters their values we have

$$d = \sqrt[3]{\frac{30{,}000 \times 8}{4{,}700}} = 7.14$$

inches for the shaft. To find the diameter of a wrought-iron shaft with a load uniformly distributed we have the following formula:

$$d = \sqrt[3]{\frac{W \times l}{9{,}400}}. \qquad (2)$$

According to this formula

$$d = \sqrt[3]{\frac{30{,}000 \times 8}{9{,}400}} = 3 \text{ inches}$$

for the diameter of shaft. For steel shafts use the same formulæ, excepting the divisors; in formula (1) use 6,300 in place of 4,700, and in formula (2) use 12,600 in place of 9,400.

(154) A. A., Shelby, Ohio, asks: What force in pounds will be necessary to stop a fly wheel suddenly? The fly wheel is 47 inches diameter, weight of rim 1,000 pounds, and running at a rate of 100 revolutions per minute. The force is applied to a wheel 10 inches diameter. Please give rules for computing this force. *A.*—The word "suddenly" is very indefinite; no fly wheel can be brought to rest instantaneously, time will be required, hence the time in which the fly wheel is to be brought to rest should have been given. We should also know the inside diameter of the rim. To show how problems of this kind can be handled, we shall assume that the fly wheel is to be brought to rest in 2 seconds, and that the inside diameter of the rim is 40 inches. The force required to bring the wheel to rest is found by the following formula:

$$f = \frac{v_a \times I}{r \times t}; \qquad (1)$$

in which f = force in pounds, v_a = angular velocity per second, I = moment of inertia of the rim, r = radius of the wheel in feet to which the force is applied, and t = time in seconds. The angular velocity is found by the following formula:

$$v_a = \frac{R \times 2\pi}{60}; \qquad (2)$$

in which R = number of revolutions of the wheel per minute, and $\pi = 3.1416$. Substituting for the letters their values, we have:

$$v_a = \frac{100 \times 2 \times 3.1416}{60} = 10.4.$$

The moment of inertia I is found as follows:

$$I = \frac{m(r_2^2 + r_1^2)}{2}; \qquad (3)$$

in which m = mass of the rim, which is found by dividing the weight of the rim in pounds by acceleration of gravity = 32.2, r_2 outside radius of fly wheel rim in feet, and r_1 inside radius of rim in feet. The mass is equal to $\frac{1{,}000}{32.2} = 31$. The outside radius of fly wheel rim is 23½ inches = 1.95 feet, and the inside radius is 20 inches = 1.66 feet. Substituting these values for the corresponding letters in formula (3) we have:

$$I = \frac{31(1.95^2 + 1.66^2)}{2} = 101.5.$$

Now, substituting the values as found above for the corresponding letters in formula (1) we have:

$$f = \frac{10.4 \times 101.5}{.416 \times 2} = 1{,}268 \text{ pounds}$$

for the force necessary to bring the fly wheel to rest in the given time.

Business Specials

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gear Wheels, Gear Cutting. Grant; see page 292.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Patents, H. F. Parker, Att'y, 26 Cort'ndt St., N.Y.

Cam-Milling. Machine Tool Works, Newark, N.J.

Marine Iron Works, Chicago (new catalog).

Pattern and Brand Letters. A variety of sizes and styles. Heber Wells, 157 William St., N. Y.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Best Presses and Dies for all sheet metal work, Ferracute Machine Company, Bridgeton, N. J.

70 Uses of Compressed Air mailed free. Clayton Air Compressor Works, 28 Cortlandt street, N. Y.

Engine Castings, 1 to 6 Horse-power Vertical. The Humphrey Foundry, Bellefontaine, Ohio.

Gardenier's "Ready Help for Locomotive Engineers." Price by mail, $1.00. Edward Meeks publisher, Philadelphia.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Improved Duplex and Special Gear Cutters in stock and to order; Gear and Milling Cutters of all descriptions. R. M. Clough, Tolland, Conn.

Squaring and Rotary Shears, Tinsmiths' Tools, Presses and Dies for sheet metal work, are made by the Niagara Stamping and Tool Co., Buffalo, N.Y.

New Jersey Art Metal Co., Passaic, N. J., finest thin and ornamental castings in brass, bronze, aluminum, etc.; machinery name plates in brass and aluminum.

"Binders" for the American Machinist. Two styles, the "Common Sense," as heretofore sold by us and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. American Machinist Publishing Co., 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 post paid. Published by John Wiley & Sons, 53 East Tenth street, New York.

"Modern Locomotive Construction." By J. G. A. Meyer. In this book the design and construction of all details of the locomotive and tender are considered from a practical standpoint. It contains illustrations of details made from working drawings, accompanied by plain directions for designing, and rules and tables for construction. Adapted to office and shop use. Price, $10. Published by John Wiley & Sons, 53 East Tenth street, New York.

Frederick E. Sickels and His Cut-off.

By W. F. Durfee.

Among the improvements made upon the steam engine as it was left by James Watt, none can take a higher rank than regulating its movements and controlling its power by what is known as an automatic variable "cut-off." No single improvement devised within the present century has contributed so much as this to establish the steam engine as the untiring work-horse of the world. It is, therefore, of great historical interest that the facts environing the origination of this improvement should be placed on record, and it is with the purpose of contributing to such a record, and of drawing out contributions from others that I write this paper.

James Watt was undoubtedly the first to discover that an economy could be attained by working steam expansively, and he described the idea in a letter to a friend in 1769, but Watt did not attempt or suggest regulating the speed and controlling the power of the engine by varying the point of cut-off automatically, as the load upon the engine varies, but he fixed the cut-off at some definite proportion of the stroke (usually one-fourth), and regulated the engine by a throttling governor. So far as the working of steam expansively was concerned, the steam engine remained for years as Watt left it in 1782 (the date of his patent for expanding steam), and no move looking towards improvement was made until 1834, when Zachariah Allen, a prominent mechanical engineer, of Providence, R. I., took out a patent for varying the point of cut-off by the action of a governor, but as I have not been able to discover just how this was proposed to be accomplished,

and as Mr. Allen's plan was not conspicuous in the extended litigation which, like the shadow of death, attended the first practical application of the variable cut-off, I am disposed to think that his invention did not possess the elements of a practical success. There is also evidence that a variable cut-off, or an effort in that direction, was placed upon the steamboat "Balloon" about 1838-9, and that another abortive attempt was made by its inventor on the "South America" in 1841, and about the same period another person made an unsuccessful experiment on the steamer "Dispatch." It does not appear that the mechanism tried on either of these boats was patented.

On May 20, 1842, Frederick E. Sickels (who died on the 8th ultimo in Kansas City), received his first patent for "a new and useful improvement in the manner of controlling the apparatus for lifting, tripping, and regulating the closing of the valves of steam engines."

The apparatus of Sickels was at once successful as a mechanism, and it continues to be used at the present time for operating puppet valves in substantially the form devised by him. It was also successful in tempting a horde of infringers and pirates to do their uttermost by law and against law to rob him of his well-merited reward, and almost immediately he was plunged into a litigation which was continued without cessation for over twenty years.

In 1843, about a year after he received his patent, an issue at law was tried (Sickels *vs.* John F. Rodman), in which the validity of the patent of F. E. Sickels was put in issue, and the jury found that "Sickels was the first and original inventor of the thing patented."

Sickels did not claim any specific means of determining at what point of the piston's stroke his valve was released, but he relied upon the broad facts that he did release the steam valve from its opening mechanism, and that the valve was closed suddenly, automatically, and that the time of its release and closing could be varied while the engine was in operation, to protect him against all possible forms of automatically releasing and closing a steam valve, and so effecting a variable cut-off. He, or the person who prepared his application for a patent, evidently thought that the release and closing of one variety of valve (puppet valve) would necessarily include the right to perform these functions with any variety of valve, and that the fact of his apparatus being made adjustable (while the engine was in operation) to vary the point of release and cut-off, would cover any form of adjustability and release. This broad view, however correct it might have been as a question of abstract right, proved to be a grave error as a matter of law.

In the years 1843, 1844 and 1845, Sickels was granted other patents for improvements in the valve mechanism of steam engines, and in the patent of the latter year he claims "The tripping of the drop valve of the cut-off by a motion independent of the lifters," and describes a motion by which the cut-off valve could be made to close at any point of the stroke.

Sickels was evidently at this time paying close attention to improving his invention, but with especial reference to its application to the puppet valve, and was apparently relying with full confidence upon what he thought was the comprehensive character of the claims of his several patents for protection against the use of his invention as applied to other kinds of valve.

The success of the inventions of Sickels naturally attracted attention from steam users, and ingenious and enterprising men, but no formidable competitor appeared until the year 1849. In that year, on March 10th, there was granted to George H. Corliss, of Providence, R. I., a patent, in which he claimed "the method of regulating the motion of steam engines by means of the centrifugal governor, by combining said regulator with the catches that liberate the steam valves, by means of movable cams or stops, substantially as described." This claim evidently confined the patentee to the use of the "centrifugal governor," and therefore the patent was surrendered, and re-issued on May 13, 1851, with the word "regulator" substituted for the words "centrifugal governor."

This invention of Mr. Corliss has been put forward as having been the first successful application of the governor to varying the point of cut-off of a steam engine, and thus make its power conform to the requirements of the work it was asked to do. This is quite erroneous; for governors had been made to vary the point of cut-off automatically several years before the date of Corliss' first patent, and they appear to have been regularly manufactured in France. Engines governed in that way were made by M. Farcot, in 1841, by M. Frey, in 1847, by M. Hallette and M. Krafft, in 1848; the two latter gentlemen used drop valves, and the former slides.

As soon as Mr. Corliss had secured his patent he commenced the manufacture of his engines, and as they proved very economical of fuel, he rapidly built up a large business, which Mr. Sickels regarded as properly his own, and he very promptly brought suit against Corliss, and on the first trial before a jury Corliss was declared an infringer. Mr. Sickels did not, however, derive any advantage from this verdict, and shortly after (in September, 1856) Judge Grier, of the U. S. Circuit Court, rendered a decision (in Sickels *vs.* Glocester Manufacturing Company, in which the defendant was really George H. Corliss) which fixed as firmly as such a decision could the legal rights of the parties. The complainant was represented by B. F. Thurston, E. N. Dickerson and C. M. Keller; and T. H. Jencks, S. Blatchford and W. H. Seward appeared for the defense. The case was contested with great vigor, and its decision by Judge Grier presents in a most clear and forcible manner conclusions which have ever since been regarded by the courts as final.

Some of the more important points of this decision will be found interesting and instructive. The defense (Corliss) set up the contention that Frederick E. Sickels "was not the original and first inventor of the thing patented." In speaking of this contention, and the evidence brought forward to sustain it, Judge Grier said: "On this point, I must say that, after a careful examination of the very voluminous and contradictory testimony relating to it, I feel satisfied that Frederick E. Sickels is the first inventor of the improved machinery for effecting a cut-off in steam engines as described in his patent. Others may have, about the same time, or even before him, conceived the idea of tripping puppet valves, that they might fall suddenly into their seats, and thus avoid wire-drawing the steam, but they failed in giving it practical effect. It required, perhaps, no great degree of mechanical ingenuity to invent a mode of detaching a valve at a given point; and it is true, also, that water has been before used to retard the motion of falling bodies; but no one had succeeded in inventing a combination of devices, by which a valve could be tripped at any given point, before or after half stroke, and made it practically useful, by adding thereto devices by which the motion or momentum of the falling valve might be arrested at the very moment of closing, without the slam or jar which would otherwise be destructive of the valve and its seat.

"That this invention of Sickels is one of great value, is clearly established; but it has met the usual fate of such inventions. Undervalued and even persecuted at first by ignorance and prejudice, when, at length, it has compelled an acknowledgment of its merits, every cotemporary failure to do the same thing is raked from oblivion, antedated, and its merits magnified by the fruitful imaginations of willing or malevolent witnesses." . . .

The learned Judge dismissed the claim that Watt used a dash pot "to prevent what is technically called 'slamming,'" as being "a problem not solved by Watt, and a result not sought for or produced by him." Of Bennett's cut-off, on the "Dispatch," the Judge says: "It was an unsuccessful attempt to do what Sickels had succeeded in doing." . . . "The evidence on this point tends to show this only—that others had perceived the benefit to arise from a sudden closing of the valves; that they had a notion that water or air might be used somehow to prevent injurious concussion but had wholly failed in devising the means to effect it."

In speaking of the invention of Hogg, erected and used on board of the "South America," the Judge said: "The truth with regard to this, when sifted out of the voluminous and contradictory testimony, seems to be that Hogg had devised a tripping apparatus about 1838–1839 for the 'Balloon,' which was not used, and which, for want of some invention to prevent slamming, never could be used successfully; that this attempt was again repeated in the spring of 1841, on the 'South America,' and experiments were made both with air and water, which were unsuccessful, till Sickels, by a letter (signed *Finisher*), suggested to them his invention, and requested them to try it. They accepted his suggestion, used his invention, and then denied his right to it.

"Several witnesses have been produced to antedate this successful use of the dash pot before the receipt of the *Finisher* letter. It is remarkable that Hogg, the pretended inventor, is unwilling to swear to the fact, while others, who were apprentices at the time, have grown up into a recollection of dates now, after fifteen years, varying from their recollection of the same events ten years before, when this issue was tried by a jury and found in favor of Sickels." . . .

"It has happened in this case, as in many others, that the party producing a witness has to rub the rust off his recollection of many things, and more especially of date In doing this he may leave marks which did not exist before. Hence witnesses are often found to swear boldly to dates, ten or fifteen years after the event, and in complete contradiction to their testimony given soon after the event; and much more may this be the case, where, under pretense of secret examination in Chancery, the answers to the interrogations are drawn up by the party or his attorney." . . .

On the question of infringement, "the most difficult question in this case," the Judge gives a long and carefully considered analytical comparison of the valve gear used by Corliss and that described in the patent of Sickels, in the course of which it is intimated that Sickels' patent does not cover all that he really invented, and the Judge declined to "inquire whether what Sickels *might have claimed* as his invention, if his specifications had been drawn up by the very able and learned counsel of complainant, with their present knowledge of the arts."

The invention of Corliss was decided not to infringe that of Sickels, because there was no mention in Sickels' patent that he contemplated the application of his improvements to other than puppet valves, the Judge saying: "Now, I do not find thus far any general abstract statement of the principle of his [Sickels] invention, or how it may be applied to any other than puppet valves. Taking the word 'principle' to mean the *modus operandi*, the specification describes how a puppet valve, raised in the ordinary way, may be tripped at any given point, but gives no intimation of any other "mode" in which he has contemplated the application of that principle to an entirely different species of valves, which are not lifted up from their seat nor disposed to fall into it by their own weight when tripped or set at liberty." . . . "Now, it is to be observed that the patentee [Sickels] does not claim to be the first inventor of the scheme of tripping valves in order to make them close suddenly and prevent wire-drawing; but thus far he claims only a combination of certain devices as an improvement in the manner of tripping the valve or setting it loose from the gearing so that it may return quickly to its seat." . . . "Experience has shown that inventions which, to support their claim to originality, were made narrow enough to pass through the eye of a needle, when once established, and in a battle with supposed infringers, become as large as camels." . . .

"I do not see the combination of the patent [Sickels] in defendant's [Corliss] machine, nor any point in it indicating how the devices described as applicable to puppet valves could be accommodated to sliding valves, nor any attempt in defendant's [Corliss] machine to invade plaintiff's [Sickels] rights by colorable evasions of his claims." . . .

"The defendant [Corliss] has to contend with the claim set forth in the patent" [of Sickels]. . . .

The final conclusion of the learned Judge was that "Corliss has invented an improved method of opening and shutting circular slides, or sliding valves; has shown another combination of devices for tripping the valve, and how his falling weight, used to close the valve, may be cushioned without jar on an air cushion. One has perfected one combination of devices for tripping a puppet valve; the other a different one for a different valve. One has discovered and perfected a water reservoir to prevent the destruction of his valves when falling into place; the other has converted his falling weight into a piston working into a socket and cushioned on air so as to break the shock of its fall. They have each perfected a different machine by appropriate devices so as to operate beneficially, and I cannot perceive that the combination of elements in each is the same, and that their difference is merely colorable and not substantial."

It is evident that Judge Grier had no respect whatever for the kind of evidence relied upon by the defense [Corliss] to deprive Sickels of the credit of being "the original and first inventor of the thing patented" by him, and, in reading between the lines of his decision, it is easy to see that the learned Judge felt that Sickels had been unfortunate in not claiming in the specifications of his patent, all that he had really invented and was entitled to protection for; in fact, Judge Grier did not hesitate to state subsequent to his decision that had Sickels' patent embraced all he really invented and was entitled to, the decision must have been quite different. Judge Grier wrote a letter (which I have seen) to that effect. No better illustration of the great importance of a careful preparation of the specifications and claims in applications for letters patent can be found than is furnished by the history of the inventions of Frederick E. Sickels.

Initial Increase of Entropy, and Thermal Lag, in Steam Machinery.

By Charles M. Jones.

In the regulation treatment of loss of thermal efficiency in the steam engine, it is assumed that the difference between the weight of water accounted for by the indicator and that actually used, is due—barring leakage—to condensation of the vapor by the cooler walls of the metallic envelope, and it is popularly supposed that a cylinder constructed of non-absorbent material, is capable of developing power with the quantity of steam corresponding to the volume of cut-off.

This erroneous impression is due, primarily, to the teachings of Hirn and Halleur, who, in the early 50s, made certain experiments upon a toy engine and boiler, and so great is the reverence in which these tests are held in certain circles, that a vast quasi-mathematical superstructure has been raised upon them, when, in fact, a very simple direct analysis is sufficient to demonstrate their practical worthlessness.

A remarkably clear illustration of such—the usual—cloudy notions of thermal effects, is to be found in an essay upon superheated steam that appeared a short time ago in an American engineering magazine.

The author, whose skill in the manipulation of the Carnot cycle cylinder, with its regulation cake of ice and lump of heated matter, has made him famous among dis-

quisitionists in discussing certain questions of legitimate engineering, makes the astonishing assertion that the well-known economy of the slow-speed, high-expanding, single-acting Cornish pumping engine is due to "absence of direct radiation to the condenser," and, furthermore, gives diagrams of the alleged interaction of the metal and vapor in certain high-speed machinery, and states that the tabulated economy with superheated steam is a consequence of the metal being saturated with heat thereby, before the vapor has been reduced to the condensation state.

That such assertions pass current as sound principles of science, is a standing commentary on the present state of theoretical engineering. In Fig. 1, let *B L* be the cushion line of an engine that works at so slow a speed that the metal of the cylinder follows the temperature changes without "lag," and, taking first *D U* as the back pressure line, consider the engine to be single-acting —to avoid the complication of discussing the crossing of steam and temperature curves—and also let the cushion line, or rather its effects, be alone considered.

The absorption of heat by the metal, during compression, will be precisely equaled by the metallic rejection during expansion (radiation losses supposed eliminated by proper jacketing and clothing), and there will be absolutely no loss of steam efficiency due to the metallic action. The work done in compression from *L* to *B* will be given out again in the expansion from *B* to *L*, the cushion line being simply more inclined to the vertical than when the cylinder surfaces are non-absorbent.

Still, neglecting certain live steam effects, which cause an interchange in the bored portion of the cylinder, too complicated for explanation in this article; let the engine be speeded until, on the compression stroke, the metal can no longer follow thermally. The cushion line will rise sharper, and to strike the *B* point, the exhaust must close later, as at *M*.

But when *B* is reached in this case, the metal is still absorbing heat, since by reason of "lag" it has not yet become saturated.

The effect on the true card will show by the cushion volume *A B* shrinking to some less quantity, as *A H*, and, in the standard language of the day, cylinder condensation manifests itself, although there may be no actual condensation whatever.

The cushion lines will be *M B* on the rise, and *H N* on the outboard stroke, and if the cushion when at the upper pressure is sensibly at the same state as the entering live steam, the latter must fill in the volume *B H*, which will not show on the indicator diagrams. The loss here is not due directly to metallic absorption, but to thermal lag.

Let the cylinder be now supposed absolutely impervious to heat, and also let there be none of that film of moisture on the surfaces, which plays so important a part in filling up the glaring discrepancies that even the most enthusiastic disciples of Hirn and Halleur find necessary to explain away. The cushion will rise upon a true adiabatic (neglecting air and argon), and if the vapor is fairly dry when the exhaust closes, on reaching *B* it will be superheated. Live steam now enters in the saturated state, and, mixing with the superheated cushion, absorbs its extra heat until the temperatures are equalized.

The cushion shrinks to—generally—saturated state under the constant pressure of the boiler, and becomes some less volume than *A B*, say, *A H*.

The live steam expands under constant pressure, until it has absorbed the extra heat of the cushion, but its coefficient of expansion—practically corresponding to the latent heat of evaporation—is very much less than that of the more gaseous superheated cushion, and especially is this so in actual cases where there is considerable moisture in the boiler vapor.

The difference between the expansion of the live and the shrinkage of the cushion steam, leaves a gap such as *B H* in the true diagram, which must be filled with additional boiler steam, with the precise practical result already found as due to thermal lag. This interaction of the live and cushion vapors is entirely ignored by Hirn and Halleur, who, anxious to discredit the beautiful Rankinean philosophy, promulgated the pure metallic theory as the true cause of the difference between the usual half-developed formula and actual experimental results. If the cushion of an engine superheats—the *proper* superheating of the live steam will prevent the shrinkage due to vapor action, and so increase the efficiency of the steam—unless the factors are so related that the increased losses due to metallic lag, under the higher total temperature, overbalance the vapor effect. If the cushion is saturated at the upper limit of pressure, and the live steam superheated, there will be losses, due both to shrink of live steam by contact with the cooler cushion, and to metallic absorption.

Roughly, the compression of fairly dry cushion, from fifteen to a hundred pounds absolute, produces an extra temperature over that of saturated vapor of between

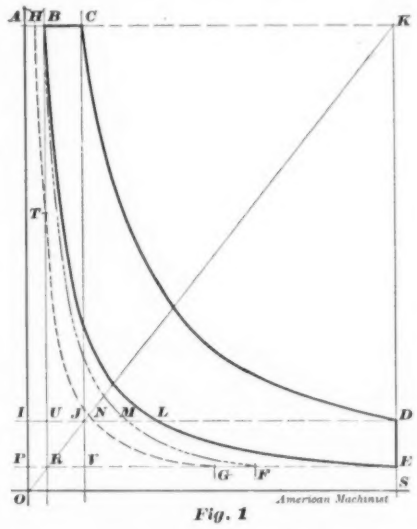


Fig. 1

seventy and one hundred degrees—from which an idea of the resulting shrinkage can be formed. The perfect engine is that which has its cushion brought to the same state as the live steam at admission, and in which there is no lag, and in which the compression line rises through the same general path as the mixed vapor falls through.

The mere metallic absorption of heat from the cushion—with or without actual condensation—exerts no direct influence on the efficiency of the steam, so long as such absorption takes place without appreciable differences of temperature between metal and vapor.

This statement holds up to the point at which the steam ceases to be homogeneous, as an abrupt change is likely to take place if water is "thrown down" bodily. Certain pulsation effects are also factors in certain cases.

In the Cornish pumping engine steam is cut off very close, so that there is little drop at exhaust.

The slow speed allows the metal to give out its heat to the working steam without lag, and on release from the steam side of piston the vapor is shifted into the opposite end of the cylinder—the piston rising with balanced pressures, by reason of the weight of pump rods and gear—and on the next down stroke the exhaust from lower end of cylinder opens to the condenser.

The live steam strikes whatever cushion vapor there may be in practically a like state of saturation, the pressures being very low there would be no superheating of cushion due to compression, although the jacketing tends to that result, and there is little, if any, vapor interchange.

Whatever the metal absorbs is taken from wet steam, the latent heat of which is so large that the volumetric shrinkage is very little, and as the forward stroke is slow the giving back of the heat by cylinder heads and piston faces takes place without appreciable difference of temperature, and, in consequence, the line corresponding to *H N* in Fig. 1, runs practically from *H* to *L* (the latter being the actual cushion point), and this reduces the absorption loss to, roughly, about half the amount that it would be in a high-speed engine having the same initial shrinkage.

A wasteful steam engine can often be made economical by covering piston faces, cylinder heads, and—where possible—port and passage surfaces, with a veneer of quick-absorbing metal, the amount of which is sufficient to reduce the cushion to the initial state of the live steam. The surfaces can also be covered with non-conducting material, and the cushion brought to the proper state by a regenerative apparatus—thin strips of metal or other proper substance—wire gauze or any such device, that will absorb the surplus heat. Or a thin layer of pure metal can be electroplated upon the non-conducting coating, or even upon the bare cylinder material, with highly beneficial results. In these cases any drop at release tends to waste heat to a greater extent than where the cylinder is of ordinary metal, and such loss must be examined in practical construction. If the cushion is saturated at *B* superheated live steam will cause a loss, while with superheated cushion, superheated live steam prevents the vapor interaction. The higher the speed of the engine, the greater is the purely vapor effect, a fact that fixes a boundary to the economy of such machinery.

The limits of this article prohibit any discussion of partial cushioning, wire drawing, and various other points vitally affecting the economy of a design—but these will be taken up in the near future, when, it is hoped, time can be found to present, in detail, a practicable method of predetermining the water consumption of any engine.

Heating, Forging and Hardening Steel.

In our modern machine shops machinists have but little business in the blacksmith shop, and seldom ever get inside of a tool room; besides, a tool dresser doesn't like to have these fellows sticking things in his fire. As a result, many of our young machinists have but little practical knowledge in either dressing or tempering tools. There are some good reasons for a machinist understanding these arts. One is, that he is often placed in a position where he may have to dress and temper his tools, and another, and not the least, is that he knows better than anyone else the shapes best suited to his work, and in doing his own tempering, has no one to blame but himself if the tool does not stand.

A few things that I have observed in tempering and dressing tools may be of interest to some of your readers.

Too high a heat, it is well known, is ruinous to steel, and in the absence of any fixed rule, I have always kept on the safe side in this matter. A little experience with any known quality of steel will determine the heat it will stand without injury. Some qualities I have found will not stand sudden heating; in fact, I think the slower heating is the best for all kinds, and a charcoal fire, or clean well-charred coal, is essential to the preservation of uniformity in quality.

Heavy blows on comparatively light steel, I have found, injure it. For example, take the usual octagon steel and draw out a chipping chisel, allowing the helper to keep up heavy blows of the sledge until the chisel is brought to the desired thinness. Then from the same bar, draw out another chisel, using lighter blows, especially as the steel is thinned and becomes colder. Temper these as nearly alike as possible, and the efficiency of the two tools will be very unlike. The first will break easily with a coarse crystallized appearance. The latter will stand harder service, and if broken will show a close silvery color. These modes of treatment, and their effects, were often seen in making and repairing picks for dressing the old style French buhr-stone. I believe the above principle should be observed in working tool steel into any shape.

In tempering, as in working steel, I will only offer a thought or two, for every worker of steel seems to have fixed notions on this subject.

I have found *lard oil* to work well as a quenching bath, especially in hardening taps, dies and reamers, but as much of the lard oil now used is adulterated with cheaper oils, it may not give uniform results. I have used clear water successfully in hardening massive articles, which are so apt to crack while cooling, but have found it best to warm the water nearly to the scalding point before dipping the steel. When the article has nearly reached the temperature of the water, I remove it to cold water as quickly as possible, for breaking usually occurs soon after an article has been exposed to the air, and before it has reached a uniform temperature from its center to the surface.

When cold water is used at first I have found it best to allow the article to remain submerged until it is quite cold, holding it in a position, as near as possible, that will allow the water to circulate alike on all sides. This is not only a guard against breakage, but also prevents springing—a thing so common and so troublesome to workers of steel. There are many well-known preparations for tempering and securing different degrees of hardness, but I have seldom had occasion to use them, and know but little as to their merits. "QUIRK."

No Engineer Wanted.

A short time ago I called upon the manager of an extensive estate, as I knew that he had begun the erection of a large building, a portion of which, I understood, was to be used for light manufacturing purposes, and asked him if he wanted to hire an engineer, as I wished to secure the position for a friend. With the utmost serenity he informed me that he did not expect to have any engineer, as he was to carry but ten pounds of steam on the boilers for heating purposes, while the power was to be supplied by electric motors, the current being furnished by the city electric company. Here then was a pair of medium-sized tubular boilers that needed no engineer to care for them, as they were to carry but ten pounds pressure.

Of course boilers that carry high pressures need more careful supervision than those which carry only low steam, but is it true that this place needed no engineer? This man's reply brought to my mind a little circumstance that occurred several years ago, and made a lasting impression. It was only a small plant, the main steam pipe to engine being but three inches in diameter, and the limit of pressure 80 pounds. The throttle valve had been opened and shut many times with a working pressure on the pipes, and nothing came of it, but one Monday morning, when getting up steam, I opened the throttle valve, having previously noted that the steam gauge pointer indicated ten pounds pressure. The valve wheel had not made a full revolution before there was a loud report, and the valve was rent as if it had been only a paper bag. Of course it was a peculiar case, but at the same time these peculiar cases are confronting us continually, and there should be a man in charge of every plant who thoroughly understands such chances of failure. A new valve was put in, and we operated it for about two years without further trouble, when the business was discontinued, and the mill closed for several months. Other parties bought the property in course of time, and it was reopened for business. Having a desire to see the old place again, I called there one day, carefully looking for the valve that I had put in to replace the broken one, and was not surprised to find that it was gone and another one in its place. I did not ask the man in charge how it was that he had to make the change, as I concluded that my experience had been duplicated. I wonder if all of the men who speak so contemptuously of these light pressures, ever stop to consider that in many of the ponderous looking compound engines, so common at the present time, the mean effective pressure in the largest cylinder does not exceed ten pounds above the atmosphere.

W. H. WAKEMAN.

A Novel Planer Chuck.

We present herewith illustrations of a planer chuck of somewhat novel construction. At each side of the slot on the underneath surface there are ratchet teeth which the bolt is adapted to engage, and this bolt is fitted with a spherical washer under the nut, so that the jaw can adjust itself to the work without cramping, and as it tightens upon the work the jaw is drawn down firmly to the bed. It can adapt itself to taper work also, and, in the case of large chucks the plan of providing two or more short jaws to be separately adjusted, enables work to be held having a degree of taper which would make it difficult to hold otherwise, and irregular shaped work is also readily held. All these chucks open as wide as the combined jaws are long, so that a 12" chuck, for instance, will hold work 12"x12'. They are made with square, circular, and graduated bases, in seven different sizes, by W. H. Ermentrout, Reading, Pa.

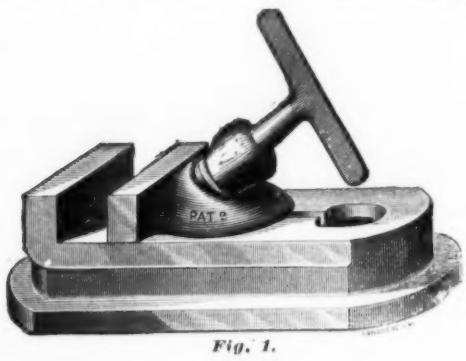


Fig. 1.

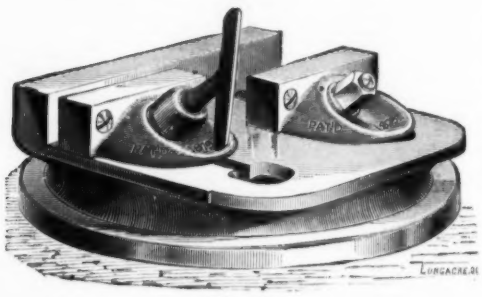


Fig. 2.

A manufacturing concern which had been carrying in our columns an advertisement of second-hand machinery, independent of their regular card, withdrew it recently, and gave as a reason that they had disposed of about all the good second-hand machinery on hand, and they then go on to say: "We take it as one of the best indications of the times that the prices on good second-hand machinery are so stiff, which, we think, indicates an increasing scarcity of such tools."

There are newspaper reports of an electric freight railroad between Chicago and New York, and it is claimed that whereas freight now takes six days for the trip, the new road will accomplish it in one day. The capital stock of the company is $200,000,000, and we believe some shares are yet for sale—and probably will be for some time yet.

The *New York Times* states that Louis A. Johnson, one of its compositors, set up on a Mergenthaler Linotype a gross total of 78,138 ems of "solid" nonpareil matter in eight hours. Deducting for corrections, the net total for the eight hours was 72,225 ems, or an average of 9,028 ems per hour.

NEW CATALOGS.

We have received from the Hogan Boiler Co., Middletown, N. Y., a pamphlet illustrating and describing a new tubular boiler, for which special claims are made in points of efficiency, convenience for repairs, freedom from explosion, etc.

We have received from J. E. Reinecker, Chemnitz, Gallenz, Germany, catalogs and pamphlets illustrating and describing various forms of milling machines, grinders, etc., such as were shown at the Chicago Exposition, and also some new forms of the "forming lathe," or lathe for relieving cutters. These, we understand, will be sent to anyone interested upon application.

We have received from the Prince Mfg. Co., 71 Maiden lane, New York, a pamphlet entitled "The Rusting of Iron and Steel; How it may be Prevented and How it is Promoted." It contains much valuable and interesting matter on this subject, but is devoted mainly to setting forth the advantages of Prince Bros.' Mineral Brown, which was formerly called Prince's Metallic Paint. The pamphlet is 6"x9¼".

We have received from the Whiting Foundry Equipment Co., Harvey, Ill., a catalog illustrating and describing improved air hoists and cranes, which are made especially with a view to their use in foundries, for which they seem well adapted. The lifting cylinders are both vertical and horizontal and are arranged in various forms to suit conditions. Illustrations and descriptions are also given of air compressors, steam and belt driven. The pamphlet is standard size, 6"x9".

We have received from Messrs. James Yocom & Son, 111-123 Drinker street, Philadelphia, Pa., an illustrated catalog of shafting and kindred transmission devices, including a large variety of pulleys, couplings, hangers, etc. Special pains have been taken, evidently, to give a very complete line of tighteners and guide pulleys for belts, and these are illustrated, apparently, in about all the forms that could possibly be called for in practice. Clutches of various kinds are also illustrated, and there are full and complete tables of dimensions, weights and capacities.

MANUFACTURES.

A saw-mill is to be built by Messrs. Cummings & Co., at Lockport, N. Y.

The Pennichuck Water Co., of Nashua, N. H., proposes to erect a new dam.

Mellville, Carter & High, of Reading, Pa., are putting up a new tin-plate plant.

Another tin-plate plant is to be built by the Norton Tin-plate and Can Co., of Baltimore, Md.

Very shortly improvements are to be made to the plant of the Pittsburgh Tin-plate Co., of New Kensington, Pa.

Plans have been drawn for the erection of a large iron plant for the Sessions Manufacturing Co., of Bristol, Minn.

George E. Molyneaux has accepted a position as salesman with the F. F. Chase Machine Works, of Plainfield, N. J.

The new plant of the Crescent Sheet and Tin plate Co., of Cleveland, Ohio, will, in April, start with full force.

The Majestic Mfg. Co., of St. Louis, Mo., has been incorporated to erect a new factory building at a cost of $75,000.

The McCullough Iron Co., of Delaware, Pa., is said to be contemplating the erection of a new galvanizing works at that place.

A cotton-mill is to be erected at Rutherfordton, N. C., by a new concern, in which W. H. Norris, of the above-named city, is interested.

The Central City Iron Works, of Stevens Point, Wisconsin, has made a number of improvements in its plant, adding to the equipment of machine shop.

Work will soon be commenced on the erection of a brick factory for the N. E. Knitting Co., of Winsted, Conn., and new machinery will be put in.

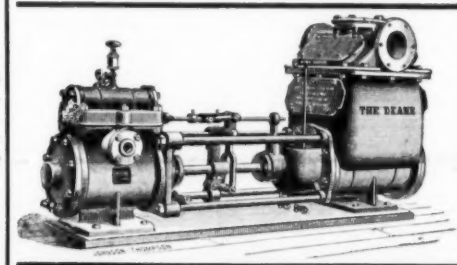
The town of Walterboro, S. C., has proposed to organize the Colleton Cotton-mills, with a capital stock of $100,000. C. A. Savage is among those interested.

An enterprise has been started at Cleveland, Ohio, to build barges, with a capital of $175,000. It will be known as the Cleveland Steel Canal Boat Co.

The Collins Co., at Collinsville, Conn., are putting up a new retort house, which will be of iron, designed and built by the Berlin Iron Bridge Co., of East Berlin, Conn.

Mr. Chas. J. Foster, M. E., who was mechanical engineer at the World's Fair at Chicago, has accepted the same position with the Cotton States and International Exposition, Atlanta, and begins work there at once.

F. H. Crafts, of Buffalo, N. Y., is about to organize a company for the manufacture of his device for changing the speed of iron-working tools. Ap-



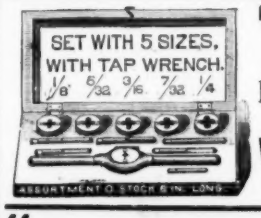
THE DEANE
OF HOLYOKE
VACUUM PUMPS,
DRY OR WET SYSTEM.
THE DEANE STEAM PUMP CO.,
HOLYOKE, MASS.
Send for "The Deane Specialties."

REDUCING VALVES
For reducing and maintaining an even steam, air or water pressure. These valves have been on the market for years, and are used by all the best and largest steam plants of the world.
MASON REGULATOR CO., Boston, Mass.
Western Office: 1649 Monadnock Building, CHICAGO, ILL.

Crescent Steel Co.
PITTSBURGH, PA.
CHICAGO, ILL.
NEW YORK, N. Y.
Crescent Extra
. . IS . .
The Best Steel you can get anywhere for Cold Chisels.

BUFFALO DRILLS.
For Blacksmith, Carriage & Wagon Manfrs.
24 SIZES.
Buffalo Forge Co.
Buffalo, N.Y. U.S.A.

BUFFALO FORGES.
Americas Best. The World's Standard.
Buffalo Forge Co.
Buffalo, N.Y. U.S.A.



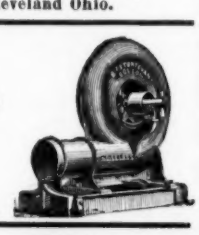
"LIGHTNING" SCREW PLATES,
For Machinists, Electricians, Bicycle Repairers, &c., Adjustable Dies with Guides.
SEND FOR CATALOGUE.
WILEY & RUSSELL MFG. CO.,
Greenfield, Mass., U. S. A.

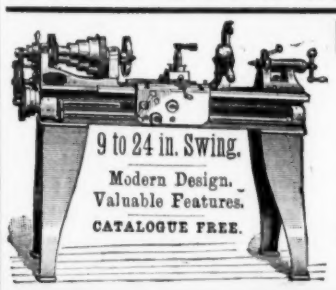
THE ENCYCLOPEDIA OF FOUNDING
BY
SIMPSON BOLLAND,
12mo, Cloth, - - - - $3.00.
JOHN WILEY & SONS,
NEW YORK.

GRANT GEARS
Ready Made Iron Gears.
Ready Made Brass Gears.
Gears Made to Order.
Gear Cutting.
1895 Gear Book, Free.
Treatise on Gears, $1.00.
GEORGE B. GRANT,
Lexington, Mass.,
and 125 South 11th St., Philadelphia, Pa.,
and 86 Seneca St., Cleveland Ohio.

"R. MUSHET'S SPECIAL STEEL"
SAVES LABOR in being able to run at GREATLY INCREASED SPEEDS. FEWER GRINDINGS. No WASTE in redressing.
SOLE REPRESENTATIVES IN THE UNITED STATES.
B. M. JONES & CO.,
BOSTON: 11 & 13 Oliver St., NEW YORK: 143 Liberty St.

BLOW YOUR CUPOLA
WITH A
"STURTEVANT BLOWER."
Send for Catalogues.
B. F. STURTEVANT CO.
BOSTON. NEW YORK. PHILADELPHIA. CHICAGO. LONDON, ENG.

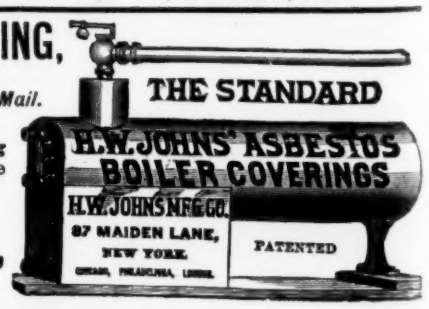




Here's a Lathe We're Proud Of!
And what's better, our customers are always highly pleased with our tools; the workmanship, material and finish are of the highest order, while our designs are the latest and most approved. We are quoting specially low prices just now. Our catalogue will tell you all about our tools—sent free.
SEBASTIAN LATHE CO.,
117-119 CULVERT ST., CINCINNATI, OHIO.

BORING AND TURNING MILLS
ARE SUPERIOR TO LATHES FOR FACE PLATE WORK.
We have a variety of sizes and a large stock for immediate shipment.
THE BULLARD MACHINE TOOL CO.,
E. P. BULLARD, Pres't. BRIDGEPORT, CONN.
New York Office, 86 LIBERTY STREET.

ASBESTOS CEMENT FELTING,
FOR LAGGING LOCOMOTIVE BOILERS.
Samples and Descriptive Price List Free by Mail.
We are prepared to take Contracts for applying Steam Pipe and Boiler Coverings in any part of the United States.
H. W. JOHNS MANUFACTURING CO.,
87 Maiden Lane, NEW YORK.



plication of this device to a lathe and to a planer was illustrated in our columns some time ago.

It is stated that the Fay & Egan Co., Cincinnati, have applied for 2,000 square feet of space at the Cotton States and International Exposition, in which to make an exhibit of their wood-working machinery, most, if not all, of which will be in operation.

The Ottaquechee Gold Mining Co., of Bridgewater, Vt., recently formed, will begin the erection of its plant as soon as the weather will permit. Its officers are E. S. Moulton, president; Geo. Reed, treasurer; J. W. Wilder, secretary; G. W. Lombard, general manager and superintendent.

A correspondent informs us that the Builders Iron Foundry, Providence, R. I., has about all the work it can handle, and a large force of men at work. They are at present building three engines, one a 300 horse-power compound, a number of hot-air engines, emery tool grinders, water heaters, reducing valves, etc.

On the morning of Tuesday, April 2d, the workshops of the Illinois Safety Heating Co. were partly destroyed by the disastrous fire which visited St. Charles. A number of valuable drawings and patterns of the company's new heater were consumed. Temporary quarters have been secured, and the company hopes to get its samples ready for exhibition within three or four weeks.

Machinists' Supplies and Iron.

New York, April 6, 1895.

Iron—American Pig—We quote standard brands, $12 to $12.50 for No. 1; $11 to $12 for No. 2, and $10.50 to $10.75 for No. 2 Plain. Southern brands, $11.25 to $11.50 for No. 1; $10.25 to $11 for No. 2; $10 to $10.50 for No. 3; $10.50 to $10.75 for No. 1 soft; $10 to $10.25 for No. 2 soft; and Foundry No. 4, $9.50 to $10.

Antimony—Prices are steady and business is fair. We quote L. X., 8¼c. to 8¾c.; Cookson's, 8¾c. to 8¾c.; Hallett's, 7.10c. to 7.15c; U. S. French Star, 7¼c.; Japanese, 7c.

Lard Oil—Prime City we quote at 51c. to 55c.

Copper—The market shows signs of improvement, a better and firmer undertone prevails, and considerable business has been transacted in Lake Copper at 9¼c. The demand for Casting Copper is not so active, 9c. to 9⅛c. is asked.

Lead—The prices have weakened, and the demand is moderate; 3.10c. is quoted for New York delivery.

Spelter—The market has a firmer tendency, but prices are irregular. We quote 3.25c. to 3.35c. for New York delivery.

Tin—The market is quiet, for current month delivery 14c. to 14.20c. has been realized; the market closed at the former figure; for May delivery 13.95c. has been obtained.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Wanted—Agents traveling and local to sell steam spec's; good commission. Mfr., 1115 State St, Erie, Pa.

Pos. wanted as draftsm'n & designer, young man 28; tech. educa'n; shop prac. Box 154, Am. Mach.

Experienced tracer wants position. Address Tisoron, 817 North Eighth St., Philadelphia, Pa.

Technical graduate wants position as draftsman. H. N., American Machinist.

Young man wants position in drafting room; references. Address T-Square, Am. Machinist.

Wanted—Pos. by young machinist as foreman of job or mfg. shop; wages mod. A. J. W., Am. Mach.

A machinery salesman wants pos.; engine, boiler & gen'l machinery experience. Practical, Am. Mach.

Gen. machinist & tool maker wants position; best refs. (16 years exp.) Address C. B., Am. Machinist.

Tool maker, first-class, wants situation; good die maker. Z., American Machinist.

Draftsman (22), tech. education, 3 years' practical exp., desires change; best refs. Box 141, Am. Mach.

Foreman patternmaker who knows his business, and how to get work done, desires engagement, immediately. Box 140, American Machinist.

Wanted—Pos. as supt. or forem'n of mach'e shop; I have valuable mech'l patent which will bring good business; good refs. W., 236 Charles St., Prov., R. I.

Wanted—A position by a practical machine tool salesman of several years experience; good references. Address Box 136, American Machinist.

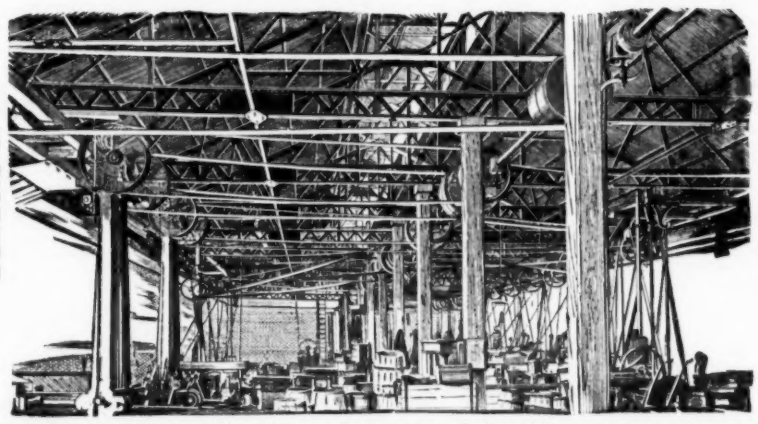
(*Continued on Page* 294.)

DON'T ACCEPT ANY SUBSTITUTE FILE.
INSIST ON HAVING
NICHOLSON

NICHOLSON FILE CO.
PROVIDENCE, R. I., U. S. A.
3000 VARIETIES FILES
[X. F.] & INCREMENT CUT FILES.

THE BERLIN IRON BRIDGE CO.
Office and Works,
No. 8 Railroad Ave., East Berlin, Conn.
CHAS. M. JARVIS, Pres. and Chief Engineer. BURR K. FIELD, Vice-President.
FRANK L. WILCOX, Treasurer. GEO. H. SAGE, Secretary.

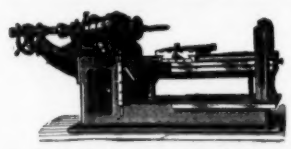
Engineers, Architects and Builders of Iron and Steel Bridges and Buildings.



The above illustration is taken direct from a photograph, and shows the construction of an Iron Truss Roof designed and built by us for the Upson Nut Co., at Unionville, Conn., over their Forge Shop. The building is 45 feet in width by 184 feet in length, with brick walls and iron roof trusses covered with corrugated iron. No wood-work is used about the construction in any way, shape or manner, so that the danger from fire is entirely eliminated. Extending the full length of the building, on the ridge, is a ventilator with swing shutters which open and close by cords from the floor.

SEND FOR OUR ILLUSTRATED CATALOGUE.

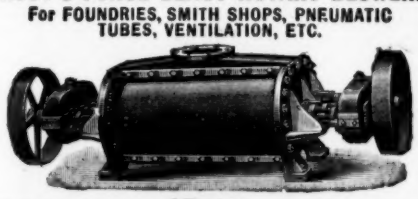
FITCHBURG TOOLS.
LATHES, Axle, Taper, Hand, Engine, Shafting, &c.
FITCHBURG MACHINE WORKS,
FITCHBURG, MASS.



Horizontal Boring and Drilling Machine.

YOU WANT OUR CATALOG E.

ROOT'S FORCE BLAST ROTARY BLOWER.
For FOUNDRIES, SMITH SHOPS, PNEUMATIC TUBES, VENTILATION, ETC.

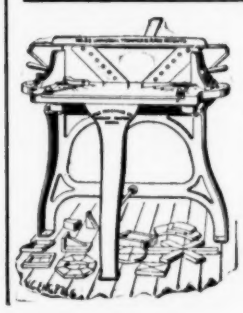


SLOW SPEED, POSITIVE BLAST, PERFECTLY BALANCED.

BEST MECHANICAL CONSTRUCTION.

P. H. & F. M. ROOTS, Manufacturers,
CONNERSVILLE, IND.
Chicago Office: 1405-10 Manhattan Building.
COOKE & CO., Selling Agents,
163 & 165 Washington St., NEW YORK.
In Writing Please Mention This Paper.

BELL'S ASBESTOS COMPANY, LTD., of London, with branches and agencies throughout the United Kingdom, Europe and the Colonies, are open to represent good American houses for the sale of Machine Tools, Pumps, and Machinery generally. Besides having extensive Show Rooms, a competent staff of practical representatives and travelers are employed. Reply with full particulars to BELL'S ASBESTOS COMPANY, LTD., Southwark, London.



THE NEW FOX
Universal Trimmer
is the only one that has an accurate adjustment of the gauges. Cannot be set wrong. Work must be correct. Time saved in Pattern-making and all wood-working.
Catalogue Free!
FOX MACHINE CO.,
325 Nor. Front St., Grand Rapids, Mich.
135 Finsbury Pavement, London, England.

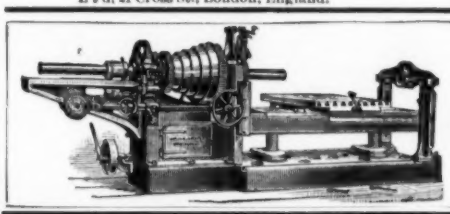
REDUCED PRICES OF LeCOUNT'S STRAIGHT TAIL DOG.

To be driven from a Stud in the Face Plate.

No.	INCH.	PRICE.	No.	INCH.	PRICE.
1	¾	$0.60	10	2¼	$1.35
2	⅞	.70	11	2½	1.45
3	1	.70	12	3	1.60
4	1⅛	.80	13	3½	1.80
5	1¼	.80	14	4	2.10
6	1⅜	.95	15	4½	2.75
7	1½	.95	16	5	3.25
8	1¾	1.10	17	5½	4.00
9	2	1.20	18	6	5.00
1 Set to 2 in.		7.80	Full Set.		31.10

These Goods are for sale by CHAS. CHURCHILL & CO., L't'd, 21 Cross St., London, England.

C. W. LeCOUNT, South Norwalk, Conn.



BETTS MACHINE CO.,
WILMINGTON, DEL.
MACHINE TOOL BUILDERS.
Improved Patterns! Late Designs!

JESSOP'S STEEL
FOR TOOLS, DRILLS, DIES, &c.
ALL KINDS IN STOCK.
Manufactory, SHEFFIELD, ENG.
Chief Am. Office, 91 JOHN ST., N. Y.
WM. JESSOP & SONS, LTD.
Established a century ago.
Medal World's Columbian Exposition 1893.

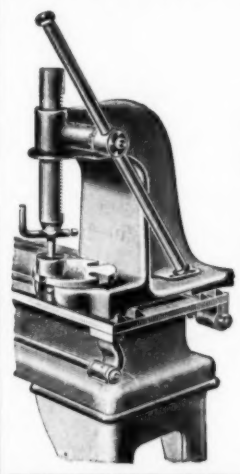
Mess. HOUGHTON & RICHARDS, Boston, Mass.
Gentlemen:—I must say that in 25 years experience with all kinds of Tool Steel I have never found a steel to compare with your Styrian Special Brand. We have planed hard steel dies with it that we could not get any other steel to cut, and the tool was scarcely dulled in doing it. Yours truly,
SPRINGFIELD DROP FORGING CO.,
A. L. Moore, Treas.

HOUGHTON & RICHARDS,
SOLE AMERICAN AGENTS,
148 & 150 OLIVER ST., BOSTON.

Star Lathes
Foot power
Screw Cutting
Automatic
Cross Feed
9 and 12 inch Swing.
New Designs. Novel Features.
Send for Catalogue B.
SENECA FALLS MFG. COMPANY
687 Water St., Seneca Falls, N.Y.

QUINT'S
TURRET DRILLS
For Drilling and Tapping with from 2 to 12 Spindles.
WILL DRILL UP TO ¾-INCH.
Sensitive and Positively Driven.
A. O. QUINT, Hartford, Conn.

The Greenerd Arbor Press.



PATENTED DECEMBER 1, 1891.
For Sale at Manufacturers' Prices by
A. J. WILKINSON & CO.
180 to 188 Washington Street,
BOSTON, MASS.
Send for Descriptive Circular.

THE BEST MECHANICS USE
MY VERNIER CALIPERS.
Ask your Dealer for them, or send for Catalogue and Special Prices to
E. G. SMITH, Columbia, Pa.

THE PERKINS DRAW STROKE TRIMMER,

An Indispensable Tool for all Bench Woodworkers. Latest and Best Design. Infringers Prosecuted. Trial, not orders, solicited.
PERKINS & CO.,
Grand Rapids, Mich.
STOCKS, NEAVE & CO.,
Manchester, England.

BUILDERS IRON FOUNDRY,
PROVIDENCE, R. I.
FOUNDERS AND MACHINISTS.
Our foundry cranes enable us to handle pieces **weighing 50 tons**, and we also make many smaller castings, even finding it desirable to have some bench molders.
Careful attention is given to the **grade of iron** required for different classes of work, and **we are prepared to guarantee** a uniform and high tensile strength when desired.
Our machine shop facilities are adequate for finishing a large part of the variety of castings which our foundry can produce, **and we respectfully solicit orders** for foundry and machine work.

WHAT'S THE MATTER
With our new Cutting-off Machines?
Write and find out.
HURLBUT ROGERS MACH. CO.,
SO. SUDBURY, MASS.

J. T. SLOCOMB & CO.,
PROVIDENCE, R. I. U. S. A.

COMBINED DRILL AND COUNTERSINK
FOR CENTERING LATHE WORK.

WORTHINGTON
PUMPING ENGINE
FOR
WATER WORKS.
SIMPLE, COMPOUND, OR TRIPLE EXPANSION, HORIZONTAL OR VERTICAL
HIGHEST DUTY GUARANTEED.
COMPLETE DESCRIPTIVE PAMPHLETS ON APPLICATION.
HENRY R. WORTHINGTON,
NEW YORK, 86 and 88 Liberty St.
BOSTON, 70 Kilby St.
PHILADELPHIA, 607 Arch St.
CLEVELAND, 24 South Water St.
CHICAGO, 185 to 189 Van Buren St.
ST. LOUIS, Eighth and St. Charles Sts.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Mechanical engineer wants responsible position; 15 years' exp. on des'g steam engines, pumps, steam plants, gen. & special mach'y. Box 157, Am. Mach.

Marine engineer and designer, with 20 years' exp. in marine engineering, desires to change; situation as supt. or chief draftsman; competent to assume complete charge; refs. Marine Engineer, Am. Mach

A first-class mechanical draftsman, middle-aged, good in designing steam engines, complete water gas works, elec. power plants, hydraulic mach'y & turbines, wishes position. Address M. L., Am. Mach.

Position wanted as superintendent by a man of large experience on engs., milling machine tools & gen. heavy work; designer of spec. tools, etc.; up in mod. methods; age 35; a pusher. Box 158, Am. Mach.

Foundry foreman is open for engagement; has had charge of a large number of men; experienced in machinery and engine work. Address Nameof, American Machinist.

Wanted—By up-to-date foreman & manager who will guarantee standard work at lowest cost of production, a position with some enterprising manufacturer who will appreciate ability and integrity. Address No Novice, care of American Machinist.

Wanted—By a large manufacturing concern near New York City, a thoroughly competent blacksmith, one who is accustomed to doing fine forging, and particularly one well up in fine hardening and tempering; to the right man a steady situation with good pay will be given. Apply by letter only to W. D. Mfg. Co., care of American Machinist.

Wanted—A competent man to take charge of the milling work in a comfortable, well-regulated machine shop; must be a first-class workman and understand the management of other men; permanent position if work is satisfactory. Address J. P. N., care American Machinist, giving age, experience, refs., salary expected, & all particulars.

Wanted—A master machinist as foreman of a marine machine shop; he must have had a large experience and practice in shops engaged in building and repairing marine engines; must be proficient in drawing and accustomed and competent to make estimates on such work; pref. would be given to a person between the ages of 30 and 45; applicants may address Master, care of Amer. Mach., giving full reply to above with refs. if practicable.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 25 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 9d hd lathes & planers. S.M.York, Clev'd, O.

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

Small tools cheap. Randall, 62 N. St., Spgfield, O.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Co., Cincinnati, O.

Light and fine mach'y to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Wanted—A purchaser for a good key-seater, by Mitts & Merrill, 913 Tilden Street, Saginaw, Mich.

For Sale—A first-class key-seater, new. Address Mitts & Merrill, 913 Tilden St., Saginaw, Mich.

Best and cheapest Bolt Header made by C. H. Baush & Sons, Holyoke, Mass.

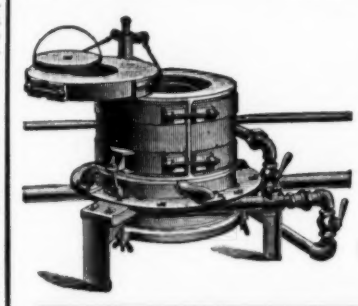
For rent in first-class locality, machine shop and foundry. J. N. Cooper, Elmira, N. Y.

Wanted—To correspond with any one in need of a first-class key-seater. Address Mitts & Merrill, No. 913 Tilden Street, Saginaw, Mich.

Party wishing machines built desires correspondence at once with up-to-date manufacturing concern. Address Box 159, American Machinist.

For sale—Patent right of the Chappell grip pipe wrench, or exchange for small engine lathe. B. F. Chappell, 129 Francis Ave., Pittsfield, Mass.

Wanted by a reliable New York firm, the representation of a good manufacturing concern in the machinery line to act as sole agents in the metropolitan district on commission; long experience and wide acquaintance in machinery lines. Address Box 155, American Machinist.



AMERICAN GAS FURNACE CO.,

OIL GAS PLANTS

Gas Blast Furnaces & High Pressure Blowers

For the economical generation and systematic application of HEAT.

CATALOGUES ON APPLICATION.

No. 80 Nassau Street, - - NEW YORK.

English Agency:
Chas. Churchill & Co., Ltd., 21 Cross Street, Finsbury, London, E. C., England.

CLEVELAND

ESTABLISHED IN 1874.

CLEVELAND TWIST DRILL CO.

100 and 102 Reade Street, New York.
85 Queen Victoria Street, London, Eng.
& Neue Promenade, Berlin, C., Germany
Cor. Lake and Kirtland Streets, Cleveland, O.

SECOND-HAND TOOLS IN STOCK,

MODERN STYLE, LOW PRICES.

ENGINE LATHES.

11 in. x 5 ft. Sebastian.
13 " x 6 " Blaisdell.
14 " x 6 " Reed with ck.
14 " x 6 " Hendey Taper.
14 " x 6 " Flather.
16 " x 6 " Blaisdell.
16 " x 6 " Prentice Bros.
16 " x 6½ " Hendey.
17 " x 10 " Lathe & Morse.
20 " x 8 " Pond.
20 " x 10 " Putnam.
22 " x 15 " Gleason.
24 " x 12 " Fitchburg.
24 " x 23 " Perkins
25 " x 12 " New Haven.
30 " x 16 " Perkins
43 " x 16 " N. Y. S. E. Co., Triple G'd.
50 in. x 18 ft. Fbg., Triple G'd.
Cabinet Turret Brass Lathe, 18 in. Chasing Bar. Carriage Feed.

DRILLS.

"Sensitive" Drills.
24 in. Prentiss B. G. Auto. Fd.
28 in. Blaisdell B. G. Auto. Fd.
Imp. Radial 3 ft. Arm.
Universal Radial 5 ft., Niles.

UPRIGHT B. & T. MILLS.

38 in. with 2 Heads. At order.
72 in. Niles, 2 Heads.

HOR. BORING & DRILLING MACHINES.

Bement No. 2, Swing 54 in.
Bement Cylinder Borer, large.

BOILER TOOLS.

Rolls, 5, 6, 8 and 10 ft.
Bement Boiler Plate Planer 16 ft. for 1 in. Plates.

PLANERS.

20 in. x 6 ft. Pratt & Whitney.
22 " x 4 " Pond.
22 " x 5 " Pease, ex. heavy.
22 " x 5 " Putnam.
24 " x 4 " Blaisdell.
24 " x 6 " Powell.
30 " x 8 " Pond.
30 " x 8 " Whitcomb.
30 " x 10 " Bancroft.
36 " x 10 " Lathe & Morse.
48 " x 12 " Fitchburg 2 H'ds.
78 " x 12 " Bement. 2 H'ds.

SHAPERS.

8 in. Stroke, Hendey.
10 " " Gould & Eber.
14 " " Fthg. Trav. Head.
15 " " Hendey.
15 " " "Fox" Crank.
17 " " Prentiss "Latest."
22 " " Triple Geared.

MILLING MACHINES.

Garvin No. 2 Hand Feed.
Brainerd No. 4 Stand. Plain.
Brainerd, No. 3 Stand. "Univ.," 16 in. Centers, Cutters, etc.
Brown & Sharpe No. 6 Plain Table 48 x 14.

SCREW MACHINES.

Pratt & Whitney No. 1 with Wire Feed, complete.
"New Pattern" with 2 in. hole, Back Gears and Auto. Turret.

MISCELLANEOUS.

Steam Hammers, 300-800 lbs.
Bradley Hammer, 40 lbs.
Stiles Presses Nos. 1, 2 and 3.
Keyseater for Pulleys & Wheels.
Gear Cutter 32 in. for Light Spur Bevel and Worms.
Auto. 1½ in. Bolt Cutter.

J. J. McCABE,

SUCCESSOR TO
E. P. BULLARD'S
N. Y. Mach'y Warerooms.

14 Dey St.,
NEW YORK.

SECOND-HAND MACHINE TOOLS.

ENGINE LATHES.

16 in. x 6 ft. Parker, Taper.
16 in. x 6 ft. Blaisdell.
16 in x 8 ft Perkins, Taper.
16 in x 8 ft. Blaisdell.
18 in. x 6 ft New Haven.
18 in x 8 ft Blaisdell.
18 in. x 10 ft. Blaisdell.
18 in x 9 ft. D. W. Pond.
26 in. x 9 ft. Lathe & Morse.
28 in. x 20 ft. Perkins.
37 in. x 14 ft. maker unknown.

PLANERS.

16 in. x 16 in. x 4 ft. Hendey.
22 in. x 22 in. x 4 ft. L. W. Pond.
22 in. x 22 in. x 6 ft. Pond Machine Tool Co.
24 in. x 24 in. x 5 ft. Putnam.

SHAPERS.

10 in. Pratt & Whitney.
12 in. Juengst, Crank.
10 in. Wood and Light Traverse Head.
18 in. Putnam, Traverse Head.
18 in. Smith & Silk, Crank.
20 in. Gould & Eberhardt.
24 in Hendey, Friction.

HAND LATHES.

4 10 in. x 41 in. Garvin.
2 12 in. x 4 ft. Stewart Pattern.
1 12 in. x 5 ft. Pratt & Whitney.
1 12 in. x 5 ft. Back Geared.
1 20 in. x 8 ft. " "

MISCELLANEOUS TOOLS.

Garvin Profiler, one spindle.
No. 2 National Bolt Cutter.
60 in. Lincoln Gear Cutter.
26 in. Pulley Lathe.
50 in. Pulley Lathe.
5 in. Cutting-off Machine.
No. 2 Springfield Tool Grinder.
No. 1 Garvin Screw Machine.
No. 2 " " "
No. 3 " " "
21 in. Squaring Shear.
14 ft. Power Draw Bench.
250 lb. Gould & E. Drop Press
100 lb. Stiles Power Drop Press.
3 75 lb. Drop Presses.
No. 31 Eaton Double-acting Press.
No. 2 Garvin Wire Spring Coiler.
Several Woodworking Machines.

Also, a large number of other machines. Write for complete list, detailed description and prices.

THE GARVIN MACHINE CO.,

LAIGHT & CANAL STS., NEW YORK.
Also, 51 North 7th St., Philadelphia, Pa.

MACHINERY FOR SALE.

12 H. P. Vertical Engine and Boiler, second-hand.
20 " " " " " " " "
Roots' Pressure Blowers Nos. 1, 2 and 6, " "
Open-die Bolt Cutter, cuts up to ¾ in., " "
" " " " " " 1¼ " " "
Lot 6¼ and 7¼ in. Shafting, Pulleys and Bearings, nearly new, at less than half value.

COOKE & CO.,

168 and 165 WASHINGTON ST., NEW YORK.

WANTED

TO BUY FOR CASH.

First-class Second-hand Engine Lathes, Planers, Drill Presses, Shapers, Milling Machines, etc., address,

The Fosdick & Plucker Machine Tool Co.,
CINCINNATI, OHIO.

MACHINERY BARGAINS

BEFORE REMOVAL.

At Phœnix Iron Works, Trenton, N. J.

15 in. x 6 ft. Engine Lathe.
18 " 8 " " "
22 " 12 " " "
24 " 12 " " "
29 " 13½ " " "
26 " 20 " " "
29 " 12 " " "
37 " 30 " " "
51 " 20 " " "
51 " 18 " " "
72 " 20 " " "

Steam Hammer, F. & M., 1,000 lbs.
19-36 and 50 in. Drills.
Portable Drill.
24 in. x 5 ft. Planer.
36 in. x 14 ft. Planer.
36 in. x 12 ft. Planer, 2 Heads.
Bement Slotter 19 in. Stroke.
2 in. Bolt Cutter.
12 in. Shaper Traverse Head.
Gear Cutter, 54 in.
Milling Machine.

10 ft.-16 ft. Vertical Boring and Turning Mill, Cranes, Blower, Boiler Rolls, Punch and Shear, etc.

Send for full list and prices.

GEORGE PLACE MACHINE CO.
145 Broadway and 86 Liberty St.,
NEW YORK.

FOR SALE.

10-TON TRAVELING CRANE,
46 ft. Span, Rope Transmission,
Also 54 in. Colliau Cupola.

A. R. KING MFG. CO.,
Erie and 11th Sts., Jersey City, N. J.

Rose's Complete Practical Machinist.

19th EDITION GREATLY ENLARGED.

JUST READY.

The Complete Practical Machinist: Embracing Lathe Work, Vise Work, Drills and Drilling, Taps and Dies, Hardening and Tempering, The Making and Use of Tools, Tool Grinding, Marking out Work, Machine Tools, etc. By Joshua Rose, M. E., author of "Mechanical Drawing Self Taught," "Modern Steam Engines," "Steam Boilers," "The Slide Valve," "Patern Maker's Assistant." Illustrated by 396 engravings. 19th edition, greatly enlarged, with new and valuable matter. 12mo., 504 pages. Price, **$2.50. By mail, free of postage, to any address in the world.**

Abstract of Contents.—Chapter I. Cutting Tools for Lathes and Planing Machines. II. Cutting Speed and Feed. III. Boring Tools for Lathe Work. IV. Screw Cutting Tools. V. Lathe Dogs, Carriers or Drivers. VI. Turning Eccentrics VII. Hand Turning. VIII. Drilling in the Lathe. IX. Boring Bars. X. Slotting Machine Tools. XI. Twist Drills. XII. Tool Steel. XIII. Taps and Dies. XIV. Vise Work; Tools. XV. Fitting Connecting Rods. XVI. Milling Machines and Milling Tools. XVII. Grindstone and Tool Grinding. XVIII. Lining or Marking out Work. XIX. Machine Tools. XX. To Calculate the Speed of Wheels, Pulleys, etc. XXI. How to Set a Slide Valve. XXII. Pumps. Index.

☞ *Price, $2.50 by mail, free of postage, to any address in the world.*

☞ *A circular of 4 pages, with specimens of the illustrations, showing the full Table of Contents, will be sent free to any one furnishing his address.*

☞ *Our New and Enlarged Catalogue of Practical and Scientific Books, 91 pages, 8vo., and our other Catalogues, the whole covering every branch of Science applied to the Arts, sent free and free of postage to any one in any part of the world who will furnish us with his address.*

HENRY CAREY BAIRD & CO.,
Industrial Publishers, Booksellers & Importers,
810 Walnut St., Philadelphia, Pa., U. S. A.

Bargains in First-Class Machine Tools.

SECOND-HAND.

1 Lodge & Davis Engine Lathe 18" swing, 16 ft. bed complete. In first-class running order.

1 Putnam Engine Lathe 24" swing, 16 ft. bed, complete. Practically as good as new.

1 L. W. Pond Engine Lathe 26" swing, 12 ft. bed, complete. In good running order.

1 L. W. Pond Planer, 38" x 38" x 10 ft. with two heads, complete. Heavy pattern, but as good as new.

1 Prentice Bros. Upright Drill 50" swing, complete. Practically as good as new.

HILL, CLARKE & CO.,
Machinery Merchants,
156 Oliver St., BOSTON.
12 & 14 S. Canal St., CHICAGO.

BLAKE & JOHNSON, Waterbury, Conn.

BUILDERS OF

PIN, SAFETY PIN, HOOK AND EYE MACHINERY,

AND LABOR-SAVING MACHINES OF EVERY DESCRIPTION.

Bent Wire Goods a Specialty. Send Samples that we may quote prices for either machine or the Goods.

E. W. BLISS CO.

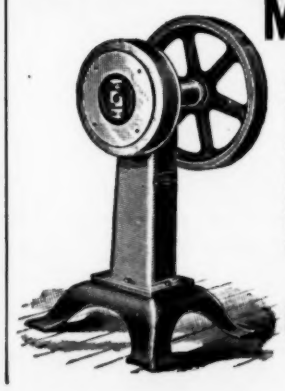
1 ADAMS ST., BROOKLYN, N. Y.
Chicago Office, 100 W. Washington Street.

DRAWING, PUNCHING, TRIMMING AND DROP PRESSES.

DIES, SHEARS AND SPECIAL MACHINERY.

OWNERS OF
The STILES & PARKER PRESS CO.

COLD SWAGING MACHINE



The Dayton Swaging Machine is the best for reducing and pointing wire and tubing. If interested address the manufacturers,

EXCELSIOR NEEDLE CO.
Torrington, Conn.

The Andrew Patent Grip Socket.

Patented May 14, 1889, and Sept. 4, 1894.

Is the original (not copied) device for holding and driving **The old system of Straight and Taper Shank Drills. With Andrew's Patent Inclined Groove** Milled in the Shank. **No more Twisted off Tangs.** Best Practical Drill Chuck in the World. **Beware of Frauds.** Infringements on these patents will be prosecuted. Send for Catalogue.

M. L. ANDREW & CO., Cincinnati, O.

STEEL BALLS

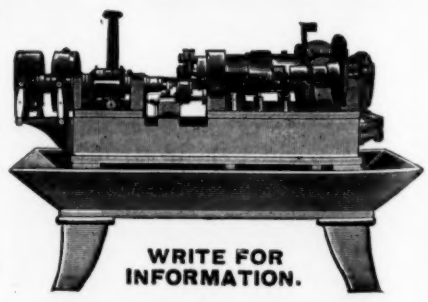
TRADE MARK — NEW PROCESS STEEL BALLS

For all Anti-Friction Purposes.

WE ALSO MANUFACTURE

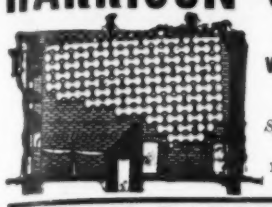
AUTOMATIC SCREW MACHINES
AND
SCREW MACHINE PRODUCT
OF EVERY DESCRIPTION.

Cleveland Machine Screw Co.,
CLEVELAND, OHIO.



WRITE FOR INFORMATION.

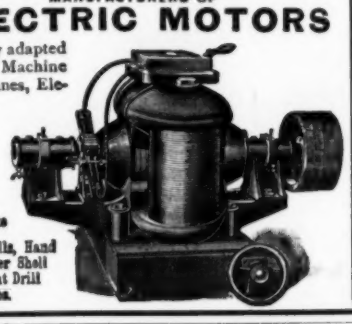
HARRISON SAFETY BOILER WORKS.



Engineers and Contractors for
Complete Steam Generating Plants, including
WHARTON-HARRISON SAFETY BOILERS, COCHRANE FEED-WATER HEATERS, HEATERS AND PURIFIERS, SPECIAL HEATERS, COCHRANE SEPARATORS, CAST IRON TANKS, &C.
Specifications and estimates furnished on receipt of details of requirements.
Works and Main Office: GERMANTOWN JUNC., PHILA., PA.
New York, N. Y.: 616 Havemeyer Building. Atlanta, Ga.: Chas. H. Willcox. Dallas, Tex.: Hunter & Booso.

THOS. H. DALLETT & CO.,

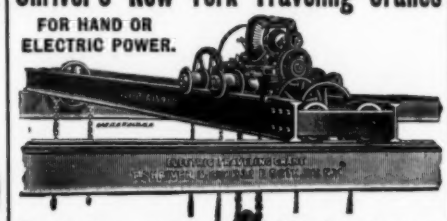
YORK ST. & SEDGLEY AVE., PHILADELPHIA.
MANUFACTURERS OF
ELECTRIC MOTORS



Specially adapted for driving Machine Tools, Cranes, Elevators, Pumps, Presses, and other Machinery.
We also make
Portable Drills, Hand Drills, Boiler Shell Drills, Light Drill Presses.

Shriver's New York Traveling Cranes

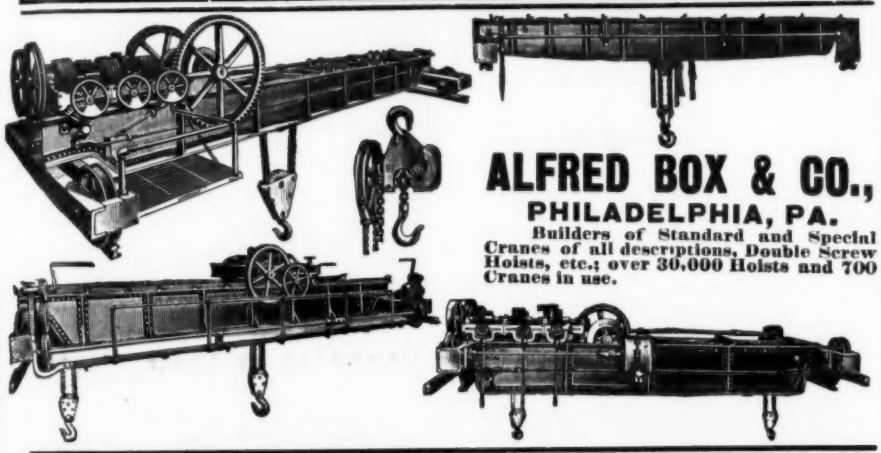
FOR HAND OR ELECTRIC POWER.



T. Shriver & Co. 333 East 56th St., NEW YORK.
MANUFACTURERS OF
TRAVELING CRANES of 1½, 2, 3, 5 and 10 Tons capacity, to be operated by Hand, or wholly or in part by Electricity.

NORTON EMERY WHEEL CO.

EMERY WHEELS.
ILLUSTRATED CATALOGUE FREE.
WORCESTER MASS.



ALFRED BOX & CO.,

PHILADELPHIA, PA.
Builders of Standard and Special Cranes of all descriptions, Double Screw Hoists, etc.; over 30,000 Hoists and 700 Cranes in use.

CRANES, TROLLEYS, PORTABLE HOISTS, OVERHEAD TRACK.

SEND FOR CATALOGUE.

MARIS BROS.,
SUCCESSORS TO
MARIS & BEEKLEY,
2343 & 2345 Callowhill St., PHILADELPHIA, PA.

EDWIN HARRINGTON, SON & CO., Inc., 1515 PENNA. AVE., PHILA., PA.

Machine Tools, Double-Chain Hoists.
Overhead Tramway,

Send for Catalogue. Mention this Paper.

MACHINERY

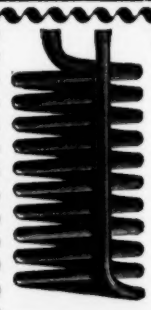
For Reducing and Pointing Wire.
ESPECIALLY ADAPTED TO POINTING WIRE RODS AND WIRE FOR DRAWING.
For Machines or Information address the Manufacturer,
S. W. GOODYEAR, Waterbury, Conn.

SPEIDEL'S PATENT

ECONOMIC SAFETY HOISTS.
OVERHEAD TRAMWAYS, TRAVELING CRANES, Etc.
SPEIDEL & ROEPER,
READING, PA.

Dixon's Silica Graphite Paint

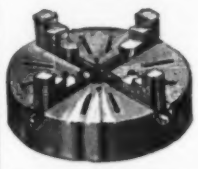
Will preserve a roof for TEN to FIFTEEN YEARS—perhaps longer, without repainting.
Unequaled for SMOKE STACKS, BOILER FRONTS, Etc.
Send for circulars on Paints and Painting.
JOS. DIXON CRUCIBLE CO., Jersey City, N. J.



COILS and BENDS of IRON, BRASS, and COPPER PIPE of every description.
The National Pipe Bending Co.
82 River St., New Haven, Conn.

WHEN YOU ORDER
HORTON CHUCKS,

See to it that our TRADE MARK
"THE HORTON LATHE CHUCK"
Is stamped plainly on their face, all others are IMITATIONS.



THE E. HORTON & SON CO.,
WINDSOR LOCKS, CONN., U. S. A.
Or CHAS. CHURCHILL & CO., 21 Cross St., Finsbury, London, E. C., Eng.

"CUSHMAN" CHUCKS.

For Lathes, Drills, Chucking and Screw Machines, and for Special work. . . . . .
SEND FOR CATALOGUE.
THE CUSHMAN CHUCK CO., HARTFORD, CONN.

FOR PLANER CHUCKS

Address G. W. JORDAN,
4 Wayne Street, Worcester, Mass.

Chucks The National.

INDEPENDENT, UNIVERSAL, or COMBINATION.
Est'd 1882. Strongest. Easiest to change. Best finish. Reversible Jaws (patented) giving 5 changes including every possible position. Illustrated Catalogue sent. Liberal discounts. Prompt shipment. Address W. WHITLOCK,
89 Cortlandt Street, N. Y.
Works, 1300 Hudson, Hoboken, N. J.

WE LEAD, OTHERS FOLLOW.

Sweetland Combination Chuck.
Reversible Jaws. Accurate, Standard Independent, Solid Shell, Solid Reversible Jaws, Strong and True.
Send for Catalogue.
The HOGGSON & PETTIS MFG. CO., - New Haven, Conn.

Cranes

CUPOLAS, LADLES, TRUCKS,
Whiting Foundry Equipment Co.,
225 Dearborn St., Chicago. | Harvey, Ill.
New York Office, 182 Front St.

IF YOU WANT ANYTHING IN THE LINE OF DROP PRESSES, DROP HAMMERS, STAMPS OR AUTOMATIC DROP LIFTERS.
SEND FOR CATALOGUE TO
Miner & Peck Mfg. Co.
NEW HAVEN, CONN.
LARGEST LINE IN THE MARKET

SEND FOR CATALOGUE.
WORCESTER MACHINE SCREW CO

WORCESTER, MASS.
Manufacturers of Set, Cap & Machine Screws, Studs, etc.

THE TAYLOR-RICE ENGINEERING CO.,

SUCCESSORS TO THE
American Standard Gauge and Tool Works.
WILMINGTON, DEL.

ADJUSTABLE BLADE REAMERS

⅛ in. to 2½ in.
Send for New Pamphlet.

"The Mills of the Gods Grind Slowly,"
BUT NOT SO OF
OUR Lathe Centre Grinder
Just the Tool for You.
TRUMP BROS. MACH. CO., Mfrs.,
WILMINGTON, DEL.

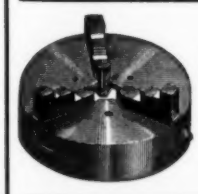
CLOUGH'S DUPLEX GEAR CUTTER.

One pair cuts from 12 teeth (and all intermediate sizes) to a Rack. For jobbing and experimental work the best. 16 P. and finer can be made to mill off tops of teeth. Kept in stock and shipped promptly. Special work to order.
Send for Circular.
R. M. CLOUGH,
TOLLAND, CONN.

PEQUOT DRILL CHUCK.

A new Drill Chuck having a more powerful grip than any chuck ever offered. This seems a broad claim, but we prove it to mechanics who will examine. Ask at your dealers or write us for particulars.
THE D. E. WHITON MACHINE CO.,
5 Oak Street, New London, Conn., U. S. A.,
Or, SELIG, SONNENTHAL & CO.,
85 Queen Victoria St., London, E. C., England.

SKINNER CHUCKS.



Independent and Universal Chucks, Combination Lathe Chucks with patent reversible jaws, Drill Chucks, Planer Chucks and Face Plate Jaws.
SKINNER CHUCK CO.,
New Britain, - - Conn.
SEND FOR CATALOGUE.

THE PRATT CHUCK CO.

CLAYVILLE, N. Y.
MANUFACTURERS OF
COLD DRAWN STEEL AND BRASS FERRULES

FROM 16 TO 24 GAUGE.
Ferrules of Every Description, Bicycle Parts, Typewriter Bells, etc.
SEND SAMPLES FOR ESTIMATES.

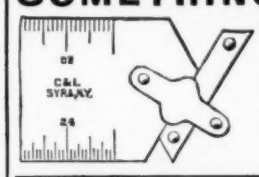
SOFT CASTINGS,

Made from best grades of Pig Iron for Light Machinery, Electric Work, etc.
THE BURR & HOUSTON CO.,
33 TO 39 FRANKLIN ST., BROOKLYN, N. Y.

THE LATEST.

OUR NEW No. 5 MILLING MACHINE
NOW READY FOR THE MARKET.
KEMPSMITH MACHINE TOOL CO.
MILWAUKEE, WIS., U. S. A.

SOMETHING NEW!

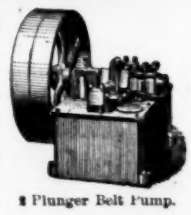


Adjustable Notch Centre Gauge.
Price, post paid, 50 cents.
Coffin & Leighton,
SYRACUSE, N. Y.

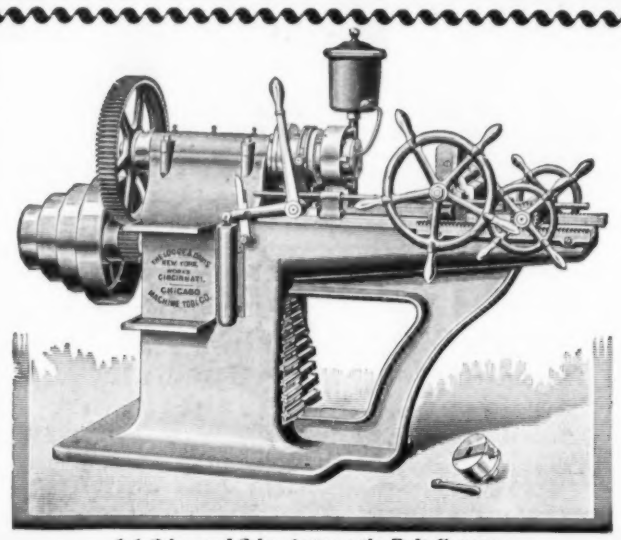
HYDRAULIC MACHINERY,

PRESSES, PUMPS, PUNCHES,
JACKS, VALVES, FITTINGS, PACKINGS,
ACCUMULATORS.
Send for Catalogue D.
The W. & S. Hydraulic Machinery Works,
WATSON & STILLMAN, Proprietors.
204, 206, 208 and 210 East 43d Street, New York.

Hydraulic Flange Packings.



8 Plunger Belt Pump.



1 1-2 in. and 2 in. Automatic Bolt Cutters.

The LODGE & DAVIS MACHINE TOOL CO.

DESIGNERS AND BUILDERS OF

MACHINE SHOP EQUIPMENTS

Including Standard Engine Lathes, Planers, Shapers, Drill Presses, Milling Machines, Screw Machines Turret Lathes, Pulley Lathes, Etc., Etc.

WORKS: CINCINNATI, OHIO, U. S. A.

NEW YORK, 110 Liberty St. | CHICAGO, 68-70 S. Canal St. | ST. LOUIS, 720 N. Second St. | BOSTON, 36 Federal St.

Lathes

OUR PAT. RADIAL DRILLS ARE BEST.

Good tools produce good work, we use only the finest machinery and employ the most skilled Mechanics, hence, are in position to offer the best Mechanisms to be obtained at a moderate price.

ENGINE LATHES.

22" and 24" furnished in lengths of 8, 10, 12, 14, and 16 feet Bed.

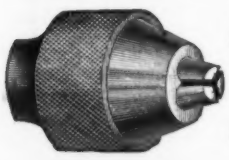
With all modern Improvements.

Address,
Dietz, Schumacher & Co.,
Cincinnati, O., U. S. A.

THE LODGE & SHIPLEY M. T. CO.,

CINCINNATI, O., U. S. A.

18 in. x 6 ft. Ratio of back gearing 12 to 1. Cone diameters 12", 10", 8", 6", and 4". Width of belt on cone 2½". Hole through spindle 1 5/16". Front bearing of spindle 3" diameter, 4½" long. Diameter of tail spindle 2". Lathe will cut screws 2 to 32. Feeds per inch 4 to 80. Weight 2,200 lbs. Will take between centers 3' 2". Swings over carriage 11". Also made in 22", 24", 27" and 30" swing.



Almond Drill Chuck.

Sold at all Machinists' Supply Stores.

T. R. ALMOND,
83 & 85 Washington St.,
Brooklyn, N. Y.

BEVEL GEARS,

Cut Theoretically Correct.

For particulars and estimates apply to

HUGO BILGRAM,
MACHINIST,
Successor to
BREHMER BROS.,
440 N. 12th St., Philadelphia, Pa.

HEAVY SLAB MILLING MACHINES.

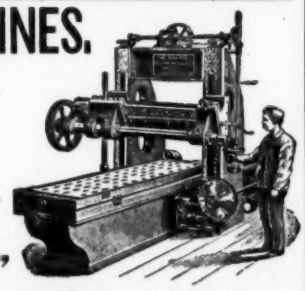
Pat. Dec. 24, 1889.

REGULAR SIZES.

60 inch	by	60 inch	by	12	feet.
48 "	"	48 "	"	12	"
36 "	"	36 "	"	8	"
24 "	"	24 "	"	6	"
15 "	"	15 "	"	4	"

PATENT CUTTERS. SPECIAL MILLING MACHINES DESIGNED.

Write for full information, photographs and prices.



THE INGERSOLL MILLING MACHINE CO.,
ROCKFORD, ILLINOIS, U. S. A.

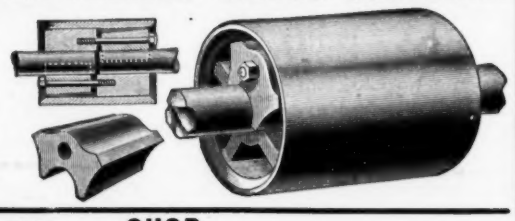
STUART'S PATENT COMPRESSION WEDGE COUPLING.

NO KEYS. KEY SEATING. SLIPPING.

CHEAPEST in MARKET, also the SIMPLEST and BEST

SENT ON TRIAL.

Can be attached or removed in a few seconds without injury to shaft or coupling. Send for discount and illustrated Price List of 40 sizes.



R. J. STUART'S FOUNDRY AND MACHINE WORKS,
NEW HAMBURGH, N. Y.

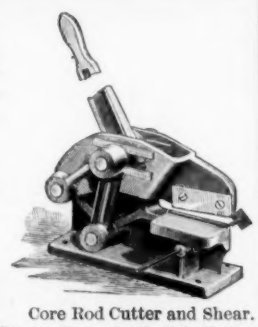
BENCH STRAIGHTENING PRESS AND CENTERS

For General Use in TOOL ROOM and MACHINE SHOP

SEND FOR CIRCULAR.

SHOP CONVENIENCES.

Our regular line embraces:
12" Crank Shaper.
15" " "
20" " "
26" Belt "
14" Hand Fox Lathe.
18" Cab. Turret "
18" Eng. Lathes.
Power Presses.



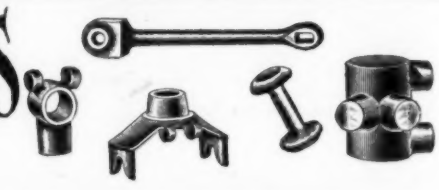
Core Rod Cutter and Shear.

THE SPRINGFIELD MACHINE TOOL CO.,
SPRINGFIELD, OHIO.

OUR AGENTS: J. J. McCabe, New York. Dawson & Goodwin, Chicago. A. B. Bowman, St. Louis. C. & M. Machine Tool Co., Boston. Thos. K. Carey & Bros. Co., Baltimore. Chas. A. Strelinger & Co., Detroit. Pennsylvania Machine Co., Philadelphia. Chas. Churchill & Co., Ltd., 21 Cross St., Finsbury, London, England.

DROP FORGINGS

WYMAN & GORDON
WORCESTER, MASS.



16" Lathe with Taper Attachment.

The Flather New Patent Taper Attachment.

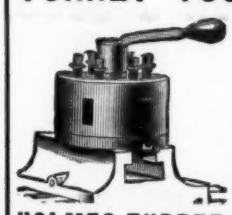
Accurate.
Easy and quick to operate.
No backlash or lost motion.
All changes can be made from front of lathe.

THE BEST.

FLATHER & COMPANY, - NASHUA, N. H.

Owing to a change in our firm we will sell our

TURRET TOOL HOLDERS



now on hand, at $16.00 for Nos. 1 and 1½, and $26.00 for No. 2 C. O. D. until March 20th.

HOLMES TURRET TOOL POST CO.,
226 La Salle St., Chicago, Ill.

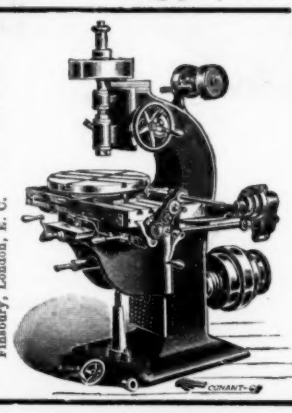
ARMSTRONG'S ✱ PIPE ✱ THREADING —AND— Cutting-off Machines

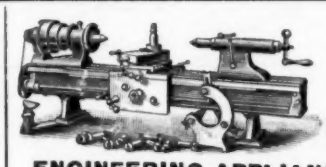
Both Hand and Power. Sizes 1 to 6 inches. Water, Gas, and Steam Fitters' Tools, Hinged Pipe Vises, Pipe Cutters. *Stocks and Dies universally acknowledged to be* THE BEST. ☞ *Send for catalog.*

Armstrong Mfg. Co.,
Bridgeport, Conn.

THE BECKER MILLER No. 4

MANUFACTURED BY
JOHN BECKER MANUFACTURING CO.,
FITCHBURG, MASS.
England—Chas. Churchill & Co. Ltd., 21 Cross St., Finsbury, London, E. C.





— FOR — Bicycle WATCH - - WORK OR TOOL ROOM.

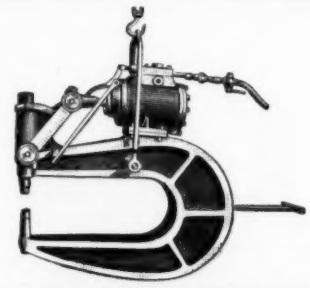
ENGINEERING APPLIANCE CO.
JAMESTOWN, N. Y.

EVERY MACHINIST SHOULD HAVE A COPY OF

OUR CATALOGUE.

It is a 704 page cloth bound book. A copy will be sent, express paid, to any one sending $1.00, and the money paid for book will be refunded with first order amounting to $10.00 or over.

MONTGOMERY & CO.,
105 FULTON STREET,
NEW YORK CITY.



ALLEN'S PATENT PORTABLE
Pneumatic Rivetters and Air Compressors.
DE BERGUE & CO., Manchester, England.

NO MACHINE TOOL BUILDER

Thinks of finishing shafts, etc., requiring accuracy by any other method than **grinding.** It is the only way **correct** work can be done: and the only method of doing it rapidly, as well as accurately, is by using water freely on the work to keep it cool and wheel clean. **We guarantee** our machine to be thoroughly adapted for the free use of water, without running over the finished portions of the machine, to be first-class in every respect and capable of finishing more work than can be done on lathes. Hence, grinding is the only proper way of finishing work, being correct (which a lathe is not) and more rapid. Send for catalogue to

LANDIS BROS., MANUFACTURERS, WAYNESBORO, PA.

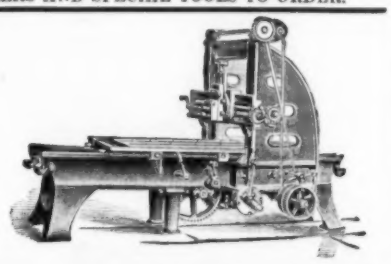
AGENTS: England: Chas. Churchill & Co., 21 Cross St., Finsbury, London, E. C.
France and Belgium: Ad'Janssens, 16 Place de la Republique, Paris.

MORSE TWIST DRILL AND MACHINE COMPANY,

Manufacturers of Morse Patent Straight-Lip Increase Twist Drills. New Bedford, MASS.

Solid and Shell Reamers, Beach's Patent Self-Centering Chuck, Bit Stock Drills.
DRILL GRINDING MACHINES, MILLING CUTTERS AND SPECIAL TOOLS TO ORDER.

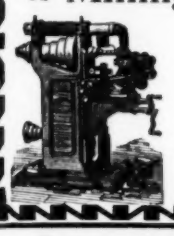
F. E. REED CO.,
Worcester, Mass.,
MANUFACTURE
ENGINE LATHES
HAND LATHES, FOOT LATHES AND MILLING MACHINES.
Manning, Maxwell & Moore,
Selling Agents, 111 Liberty Street, New York.
60 South Canal Street, Chicago.
424 Telephone Building, Pittsburgh, Pa.



New Haven Manf'g Co.,
NEW HAVEN, CONN.
IRON-WORKING MACHINERY.
MAGNET WIRE BARGAINS,
DYNAMO AND MOTOR CASTINGS.
ELECTRIC VENTILATING BY FAN MOTORS. ALSO BATTERIES
WHERE ELECTRIC POWER IS NOT AVAILABLE.
IMPERIAL ELEC. SUPPLY CO., Cleveland, Ohio.

NEW LINE OF ENCINE LATHES.
DRAPER MACHINE TOOL CO.
SUCCESSOR TO LATHE & MORSE TOOL CO.
WORCESTER, MASS.

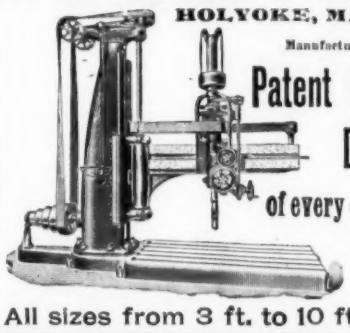
A Milling Machine or · · · ·



a Cutter and Tool Grinder.
If you need either, and where is the shop that doesn't? write
The Cincinnati Milling Machine Co.,
Cincinnati, Ohio.

A FULL LINE OF STANDARD
B. G. P. F.
FROM 22" to 36"
INCLUSIVE.
Best all around Drills in the Market.
J. E. Snyder,
Worcester, Mass.
36 in. B. G. P. F.

C. H. BAUSH & SONS,
HOLYOKE, MASS.
Manufacturers of



Patent Radial Drills of every description.
All sizes from 3 ft. to 10 ft. arm.

BRAINARD MILLING MACHINE CO.
156 Oliver St., Boston, Mass. Works at Hyde Park, Mass.
Milling and Gear-Cutting Machines,
Universal, Tool-Room, Plain and Special Milling Machines; also Gear and Cam-Cutting and Mill-Grinding Machines.
50 Different SIZES and STYLES. Cuts and Prices on Application.

ARMSTRONG LATHE AND PLANER TOOL.
Used and endorsed by J. A. Fay & Egan Co., Morse Twist Drill and Machine Co., Wiley & Russell Mfg. Co., Fitchburg Machine Works and by all who have given it a trial.

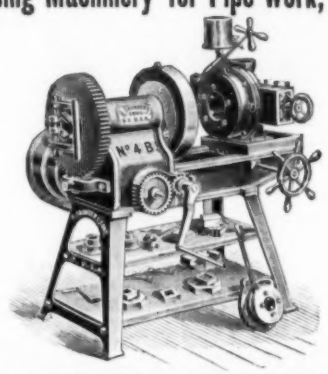
Send for circular and prices.
MFG. ONLY BY
Armstrong Bros. Tool Co.,
76 EDGEWOOD AVE., CHICAGO.

PRENTICE BROS., Worcester, Mass.

Standard Tool Room Lathe.
Double Back Geared Head.
11 to 21-inch swing.
Makers of Vertical Drill Presses, 12 to 50-inch swing, Radial Drills, Gang Drills, Boiler Makers' Drills, Radial Drilling and Countersinking Machines, for ship plate and bridge work, Special Drilling Machinery
Engine Lathes from 11 to 21-inch swing, any length of bed, with single or double back-geared heads and any style of rest, with or without taper attachment. SEND FOR CATALOGUE.
FOREIGN AGENTS:
CHAS. CHURCHILL & CO., L't'd, London, Eng.
SCHUCHARDT & SCHUTTE, 59-61 Spandauerstrasse, Berlin, Germany.
ADPHE JANSSENS, 16 Place de la Republique, Paris, France.

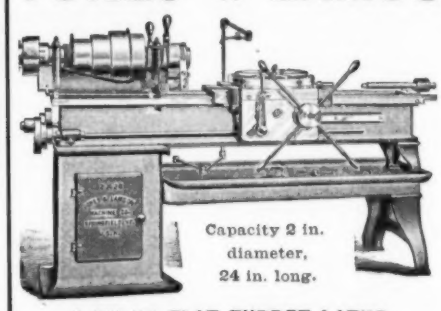
BOSTON GEAR WORKS
Frank Burgess, Prop., 35 Hartford St., Boston, Mass.
Any size or style. Spur, Bevel, Spiral, Ratchet, Worm, Rack, Elliptic, Internal, etc. Small or large.
Send for Catalogue. 1,100 sizes of Gears.

D. SAUNDERS' SONS,
MANUFACTURERS OF
PIPE CUTTING AND THREADING MACHINES,
Steam and Gasfitters' Hand Tools,
Tapping Machinery for Pipe Work, etc.



The No. 4 B Machine for Cutting and Threading Pipe ⅛ in. to 4 in., by HAND or POWER.
SEND FOR CATALOGUE TO
21 Atherton St., YONKERS, N. Y.

JONES & LAMSON MACHINE CO.,
SPRINGFIELD, VERMONT.



Capacity 2 in. diameter, 24 in. long.
2 BY 24 FLAT TURRET LATHE.

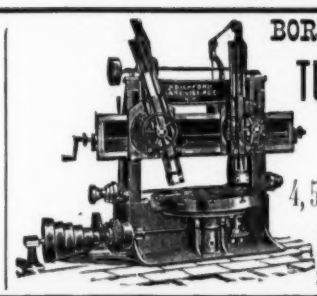
Sole builders of the Flat Turret Lathe, also builders of other Turret Machinery. Publishers of "Rapid Lathe Work," by new method (Hartness System). Send for catalogue.

MECHANICS
Mechanical Drawing; Electricity; Architecture; Architectural Drawing and Designing; Masonry; Carpentry and Joinery; Ornamental and Structural Iron Work; Steam Engineering (Stationary, Locomotive or Marine); Railroad Engineering; Bridge Engineering; Municipal Engineering; Plumbing and Heating; Mining; Prospecting; the English Branches.
The courses commence with addition in Arithmetic, so that to enroll it is only necessary to know how to read and write. A Scholarship entitles the holder to tuition, until he is qualified to receive the Diploma, no matter how long it may take nor how often it may be necessary to review. Students can interrupt their studies and change their residences. Scholarships are not forfeited upon failure to pay installments promptly. Each student is a class by himself, and has the advantage of individual direction by a competent instructor. Students make rapid progress in learning to Draw and Letter. Specially prepared Instruction and Question Papers, Condensed, Simplified. The Steam Engineering course is intended to qualify engineers to secure Licenses. All representations may be relied upon.
Send for Free Circular, stating the subject you wish to study, to
The International Correspondence Schools, SCRANTON, PA.

TAUGHT BY MAIL
THOROUGH PRACTICAL
TRADE MARK REGISTERED.

BACK VOLUMES OF THE AMERICAN MACHINIST
For any of the fourteen years, 1880 to 1894, inclusive, may still be obtained, but must be ordered soon, as our stock is nearly exhausted. Price unbound, $3.00 per volume postpaid. Bound in cloth, $4.00 per volume (purchaser paying freight or express charges). No separate back numbers prior to 1894 are now carried in stock. Only complete volumes furnished prior to 1894. Readers desiring to complete their files or obtain separate issues for the year 1894 are advised to order soon, before our limited reserve stock is exhausted.
AMERICAN MACHINIST, 203 Broadway, New York.

P. BLAISDELL & CO.,
Manufacturers of
Machinists' Tools,
WORCESTER, MASS.



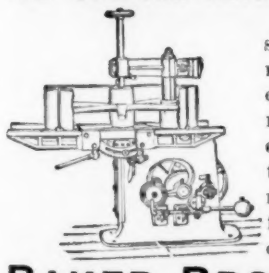
BORING AND TURNING MILLS,
4, 5, & 6 ft. Swing
H. Bickford,
LAKEPORT, N. H.

W. D. FORBES & CO.,
ENGINEERS,
1300 HUDSON STREET, HOBOKEN, N. J.

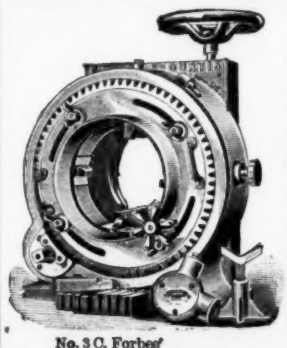
BINDING POSTS, CONTACT BUTTONS AND ALL ELECTRICAL MACHINE WORK.
(TWO BLOCKS FROM 14TH ST. FERRY.)

FINE MACHINE WORK,
LIGHT FORGING,
DRAUGHTING AND DESIGNING.

THE COLBURN KEYWAY CUTTER.

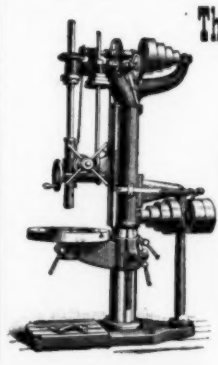


Built in four sizes. Combines many points of excellence. For rapid work and exact duplication of same it has no equal. Send for illustrated catalogue.
BAKER BROTHERS,
365 S. Erie St., TOLEDO, OHIO.



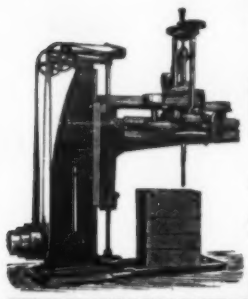
No. 3 C. Forbes' Patent Die Stock. Range 2¼ to 6 inches R. H.

CURTIS & CURTIS,
66 GARDEN ST., BRIDGEPORT, CONN.
Pipe Cutting and Threading Machinery, FOR HAND OR POWER,
RATCHET DRILLS, RATCHET DIE STOCKS AND MALLEABLE IRON PIPE VISES.

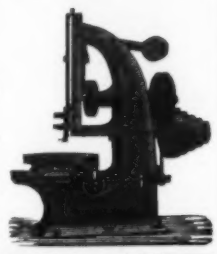


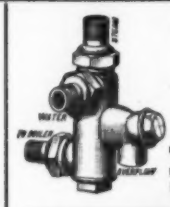
The Aurora Tool Works,
AURORA, IND.
BUILDERS OF
UPRIGHT AND RADIAL DRILLS.

BARNES' UPRIGHT DRILLS
Complete line, ranging from our New Friction Disk Drill, for light work, to 42-inch Back Geared Self Feed Drill.
Send for Catalogue and Prices.
W. F. & JOHN BARNES CO.,
1995 Ruby St., Rockford, Ill.
ENGLISH AGENTS,
CHAS. CHURCHILL & CO., LTD.,
21 CROSS ST., FINSBURY, LONDON, E. C., ENG.

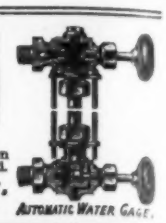


WM. SELLERS & CO., Incorporated,
PHILADELPHIA, PA.
MANUFACTURERS OF
MACHINE TOOLS,
TRAVELING CRANES AND SWING CRANES,
Operated by Electricity, Shafts or Independent Engines.
Turn Tables, Testing Machines, Shafting, Pulleys, Hangings, Couplings, etc.
INJECTORS FOR ALL CLASSES OF BOILERS.



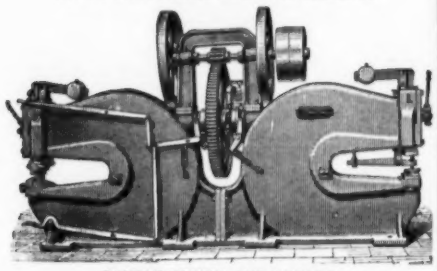


—THE—
PENBERTHY
SPECIALTIES.
FOR THE BOILER AND ENGINE. ARE THE ENGINEERS' FAVORITES.
85,000 PENBERTHY AUTOMATIC INJECTORS in use, giving perfect satisfaction under all conditions. Our Jet Pumps, Water Gages and Oil Cups are Unequalled.
SEND FOR CATALOGUE. PENBERTHY INJECTOR CO. DETROIT, MICH.
BRANCH FACTORY AT WINDSOR, ONT.



AUTOMATIC WATER GAGE.

THE LONG & ALLSTATTER CO.,
HAMILTON, OHIO, U. S. A.
OVER 300 VARIETIES AND SIZES OF



DOUBLE PUNCH AND SHEARS.

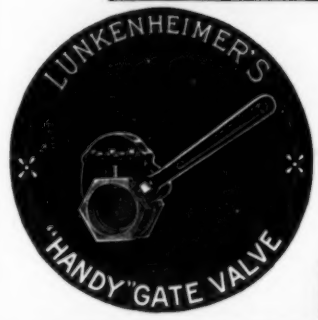
PUNCHES AND SHEARS WELDING MACHINES AND DROP HAMMERS.

STARRETT'S FINE
TOOLS

Skilled mechanics prefer them. Live dealers sell them. Send for Catalogue. . . . . .
L. S. Starrett
ATHOL, MASS., U. S. A.

CHAS. A. STRELINGER & CO.,
Tools, Supplies and Machinery,
DETROIT, MICH.

HANDY GATE VALVES

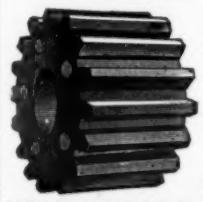


Whenever you want a convenient, compact, simple and durable quick opening valve for PRESSURES BELOW 75 LBS., use "LUNKENHEIMER'S HANDY VALVE," and you make no mistake. Its adoption saves time, labor, and money. Just the valve for STEAM, WATER, GAS, OIL, etc. Discs and lever remain stationary at any desired opening.

Made in sizes from ¼-in. to 8-in. in Brass, Iron Brass Mounted, and All Iron. SPECIFY and INSIST upon "LUNKENHEIMER'S." None genuine without our name. Catalogue of numerous "up to date" Specialties will interest you. Gratis upon request.

THE LUNKENHEIMER COMPANY,
FACTORIES — CINCINNATI, O.
NEW YORK STORE, 51 JOHN ST.
EUROPEAN STORE, THE LUNKEN VALVE CO. 35 & 37 COVER ST. LONDON, S.E.

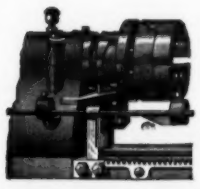
STRANGE, BUT TRUE!!
THE NEW PROCESS RAW HIDE GEARS
ASTONISH THE
MACHINERY WORLD.



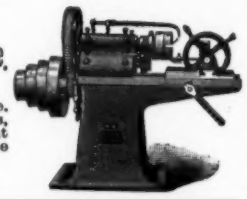
They **Outwear** any Metal.
They require **No Lubricant.**
They are **Noiseless and Clean.**
NEW PROCESS RAW HIDE CO.,
PATENTEES AND SOLE MANUFACTURERS,
SYRACUSE, N. Y., U. S. A.

MARKING MACHINE,
For rolling trade-marks on flat or round Iron or Steel surfaces. Used by Cutlery, Pistol, Twist Drill, Wrench, and many other mfrs. 200 in use. Read up. Catalogue "B" free.
DWIGHT SLATE MACHINE CO.,
HARTFORD, CONN.

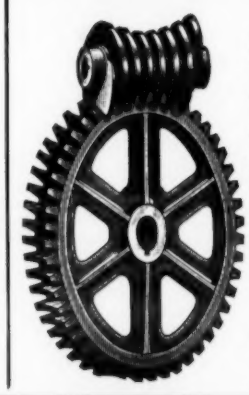
DETRICK & HARVEY MACHINE CO.,
BALTIMORE, MD.
MANUFACTURERS OF THE
ADAMS
Automatic Bolt-Threading and Nut-Tapping Machine,
Made in all Sizes to Cut from 1-4" to 6".



The simplest and most durable machine in existence. The threading head is made entirely of steel. No links, levers, springs, caps, cases, blocks or die rings in or about the head. Separate Heads and Dies Furnished. Write for descriptive circular and price list.
Manufacturers of The Open Side Iron Planer.



Albro Worm and Worm Gear

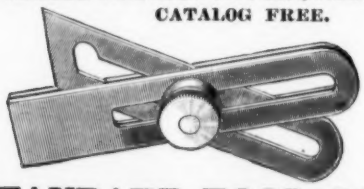


Consumes less power and gives better results than any other System. Information cheerfully furnished.
The Albro-Clem Elevator Co.,
411 & 413 Cherry St.,
Philadelphia, Pa.

Stover Power Hack Saw and Friction Drills.

Saws made in two sizes Nos. 1 and 2. Cut 4½ to 8 inches. Send for circulars to
STOVER NOVELTY WORKS
Mfgrs. of Wood and Iron-Working Machinery Special Machinery to order.
23 River St., FREEPORT, ILL., U. S. A.
C. W. BURTON, London, Eng.

3-INCH UNIVERSAL BEVEL.
MAILED TILL JULY 1ST FOR $1.00.
CATALOG FREE.

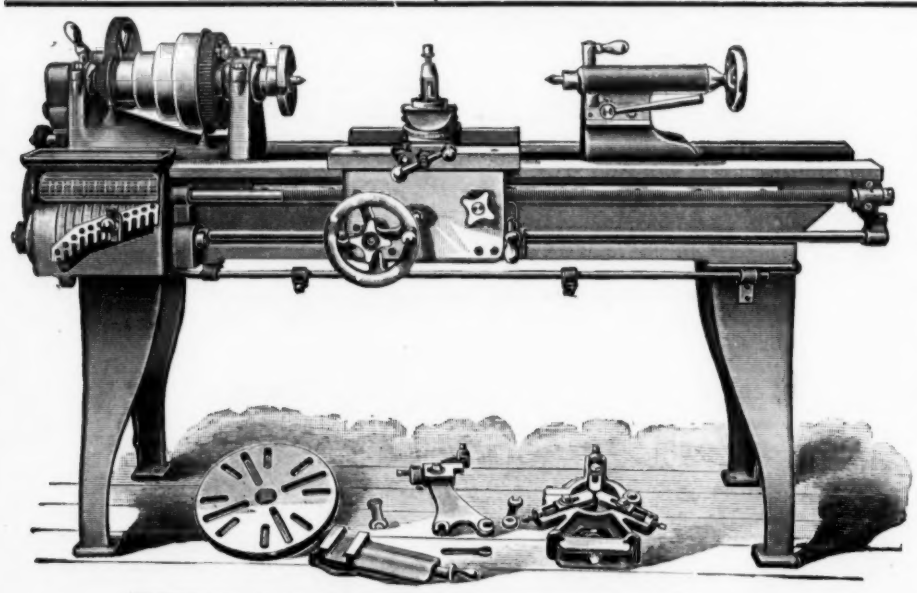


STANDARD TOOL CO.,
ATHOL, MASS., U. S. A.
MANUFACTURERS OF
MECHANICS FINE TOOLS.

SEND FOR CATALOGUE OF
SWEET'S
ENTRAINED WATER SEPARATOR.
THE DIRECT SEPARATOR CO.,
SYRACUSE, N. Y.

Special Screws and Studs in Brass or Steel.
Gear Cutting, Sheet Metal, Stamping. Automatic Machinery built to order. Send sample or drawing for estimate.
SITTMANN & PITT,
353 ADAMS ST., BROOKLYN, N. Y.

W. C. YOUNG MFG. CO., WORCESTER, MASS.
Foot Lathes, Engine Lathes,
SHEARS AND PUNCHES.



14 in. x 6 ft. Hendey-Norton Lathe with Improved Automatic Stop.

THIS Lathe COMBINES the LATEST and BEST Improvements. Automatic Stop. It is Simple, Durable, Indispensable. It will AUTOMATICALLY STOP the Carriage in EITHER direction. It is equally efficient whether FEEDING or THREAD-CUTTING. Running up to a shoulder, boring to BOTTOM of holes, or INTERNAL THREAD-CUTTING. No danger of spoiling either tool or work. It is a safeguard against accidents, in either direction.

Feeds—It has all feeds in daily use with simple movement of lever.

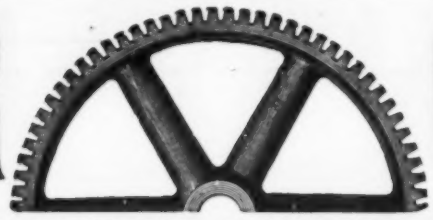
Threads—It has all threads in daily use with simple movement of lever.

Carriage—The Carriage reverses in Apron. No slamming of Countershaft. There is no Comparison between this Lathe and the old style or common lathe. Quick work, rapid changes, satisfactory results. Buy the best. Send for Circular.

EUROPEAN AGENTS:
CHAS. CHURCHILL & CO., L'd 21 Cross Street, Finsbury, London.
SCHUCHARDT & SCHUTTE, 59 Spandauerstrasse, Berlin.
SOLLER, Basel, Switzerland.

THE HENDEY MACHINE CO.,
TORRINGTON, CONN.

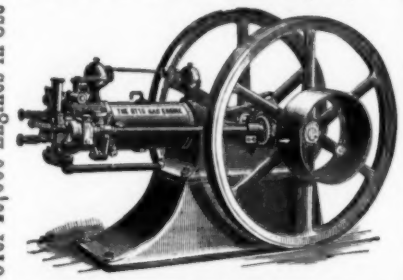
GEARS CUTTING



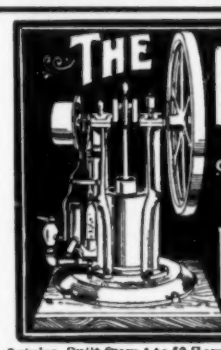
LELAND, FAULCONER & NORTON CO. Detroit, Mich.

"THE OTTO" GAS ENGINE WORKS,
33d and Walnut Sts., PHILADELPHIA.
Branch Office, 245 Lake St., CHICAGO.
New York Agency, 18 Vesey St., N. Y.

Over 40,000 Engines in Use

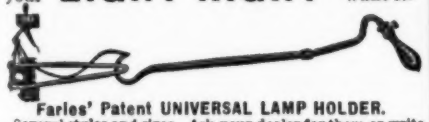


THE BACKUS GAS ENGINE



2 styles, Built from 1 to 50 Horse Power. Send for Circular.
BACKUS WATER MOTOR CO., Newark, N. J.
Also Mfrs. VENTILATING FANS.

Place your LIGHT RIGHT where you want it.

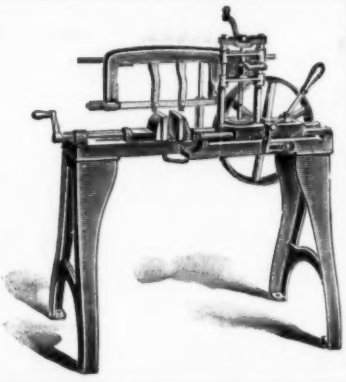


Faries' Patent UNIVERSAL LAMP HOLDER.
Several styles and sizes. Ask your dealer for them or write direct to FARIES MANUF'G CO., Decatur, Ill.
Catalogue free.

KEUFFEL & ESSER CO.
NEW YORK.
Branches: 111 Madison St., Chicago.
708 Locust St., St. Louis.
DRAWING MATERIALS AND Surveying Instruments.
The largest and best assorted stock in America. All requisites for field and draughting room. We have made a study of this line, and our goods are warranted to be as nearly perfect as it is possible to make them. Prices reasonable.
CATALOGUE ON APPLICATION.

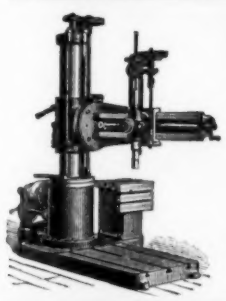
"PRACTICAL DRAWING."
By J. G. A. MEYER.
The demand for back numbers of the American Machinist, containing this valuable series of articles, has been so great, that notwithstanding it has compelled us to issue special reprints of several of the articles, our stock is now limited to complete sets with the exception of two or three issues, and orders can hereafter be filled by the set only.
A number of engineering schools are using these articles in lieu of a text book on this important branch of mechanics.
The set of 92 papers will be sent by mail to any address in the U.S., Canada or Mexico for $5.00, postpaid, and to any foreign country for $7.00.
Order now before our stock of papers is exhausted.
ADDRESS:
American Machinist,
203 BROADWAY,
NEW YORK.

WILL SAVE ITS COST
IN SIXTY DAYS.

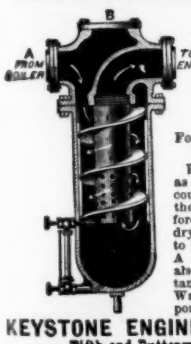


THE Q AND C
Automatic Feed,
Horizontal Stroke,
SHOP SAW
THE Q & C CO.
703-707 Western Union Bldg., Chicago.
29 Broadway, New York.

CONOVER'S
IN STOCK HANDSOME CATALOGUE ON CONDENSERS
THE CONOVER MFG. CO. 39 CORTLANDT ST. N.Y.



OUR LATEST PRODUCTION.
No. 0 Radial Drill. Something entirely new. Advantages for all shops. Now ready for you.
BICKFORD DRILL AND TOOL CO.,
3 Pike Street, Cincinnati, Ohio.

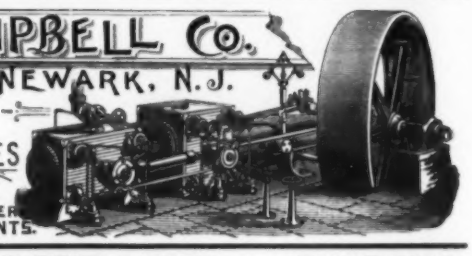


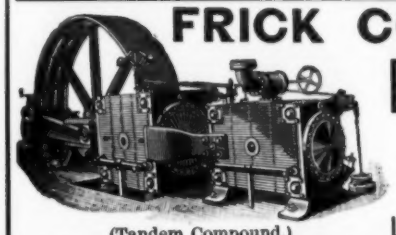
DRY STEAM.
Simpson's Centrifugal Steam Separator.
For Supplying Clean and Dry Steam to Engines, Dry Houses, etc.
Place Separator as close to engine as possible, the steam taking a spiral course between the threads causes the water to be thrown by centrifugal force against the outer walls, while the dry steam goes through the small holes to center of pipe. Steam can enter at A or B, as convenience may require; also used in conveying steam long distances, for Steam Hammers, Dry Houses, Water Gas Generators, and for all purposes where Dry Steam is necessary.
KEYSTONE ENGINE & MACHINE WORKS,
Fifth and Buttonwood Streets, Philadelphia.
THOMAS HOEY, 147 Sumner St., E. Boston, Mass., Agent.
JAS. BROOS & CO., 9 Dey St., New York, Agents.

MOFFET PORTABLE DRILL.
UNSURPASSED AS A REAMER.
Will work in any position.

Weighs 42 lbs. and drills from 3/4 to 2 inches diameter.
Runs with Steam —OR— Compressed Air.
Send for Circular.
Manufactured by
J. G. TIMOLAT,
89 & 91 S. Fifth Ave.,
NEW YORK.

THE WATTS, CAMPBELL CO.
MANUFACTURERS OF IMPROVED CORLISS STEAM ENGINES IN FULL VARIETY.
NEWARK, N. J.
CONTRACTS TAKEN FOR COMPLETE POWER PLANTS.

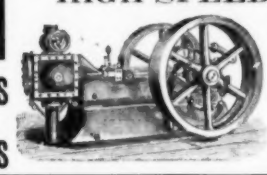




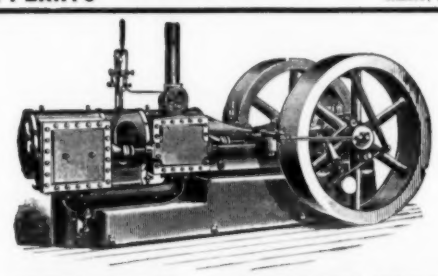
(Tandem Compound.)

FRICK COMPANY, WAYNESBORO, PA.
ECLIPSE CORLISS ENGINES,
40 TO 2,000 H. P., ALL STYLES.
Send for Illustrated Catalogue.
ALSO BUILDERS OF
Electric High Speed Engines and Ice-Making and Refrigerating Machinery.

WESTON AUTOMATIC HIGH SPEED ENGINES

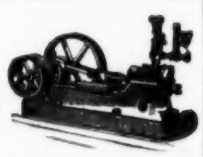


HIGH PRESSURE BOILERS AND COMPLETE POWER PLANTS
WESTON ENGINE CO., Painted Post, N. Y.
REPRESENTATIVES.
Julian Scholl & Co., 126 Liberty St., N. Y. City.
Scranton Supply & Machinery Co., Scranton, Pa.
Hoffman-Russell Co., 82 Lake St., Chicago, Ill.
Thos. K. Carey & Bros. Co., 26 Light St., Baltimore, Md.



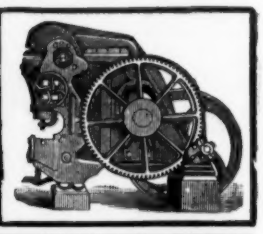
AMES IRON WORKS, OSWEGO, N. Y.
38 Cortlandt St., New York City. | 50 Oliver St., Boston, Mass.
18 South Canal St., Chicago, Ill. | 1026 Filbert St., Philadelphia, Pa.

ORR & SEMBOWER,
(INCORPORATED.)
READING, - - - PA.
VERTICAL, HORIZONTAL, MARINE and HOISTING ENGINES and BOILERS.
Special discounts to Machinists and Dealers.
WRITE FOR CATALOGUE AND PRICES.



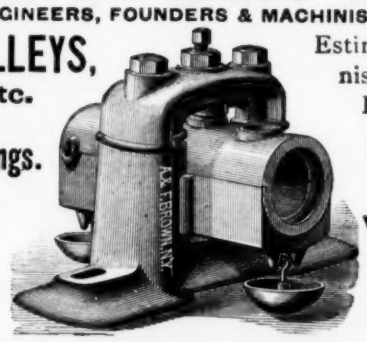
THE LANE & BODLEY CO.,
CINCINNATI, OHIO.
ENGINES,
ALL SIZES.
Simple and Compound
CORLISS ENGINES A SPECIALTY.
HEAVY SLIDE VALVE ENGINES,
Shafting, Hangers, Pulleys, Belt Elevators, etc.

PUNCHING AND SHEARING MACHINERY
AND BOILER MAKER'S ROLLS.
NEW DOTY MANUFACTURING CO.
JANESVILLE, WISCONSIN.



STEEL CASTINGS
FROM 1 TO 40,000 POUNDS WEIGHT.
Of Open Hearth, Chester or Bessemer Steel.
True to Pattern. Sound. Solid.
GEARING OF ALL KINDS, CRANK SHAFTS, KNUCKLES FOR CAR COUPLERS.
Cross-Heads, Rockers, Piston-Heads, etc., for Locomotives. Steel Castings of Every Description.
CHESTER STEEL CASTINGS CO.,
Works, Chester, Pa. Office, 407 Library St., Philadelphia, Pa.

A. & F. BROWN,
ENGINEERS, FOUNDERS & MACHINISTS.
SHAFTING, PULLEYS, HANGERS, Etc.
Friction Clutch Couplings.
STEAM SIRENS, [WHISTLES].
Send for Catalogue.
17 Dey St., New York.

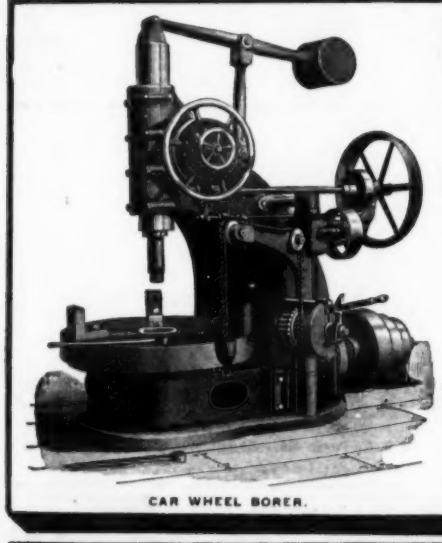


Estimates and Plans furnished for transmitting Power by HORIZONTAL AND VERTICAL SHAFTING.
Also for Erecting same.

BROWN & SHARPE MFG. CO.,
PROVIDENCE, R. I.

Internal Gauges,
External Gauges,
Caliper Gauges,
Rubber Gauges,
Centre Gauges,
Wire Gauges,
Drill Gauges,
Screw Gauges,
Verniers,
Micrometers.

England—BUCK & HICKMAN 280 Whitechapel Road, London, E.
England—CHAS. CHURCHILL & CO., Ltd., 21 Cross St., Finsbury, London, E. C.
Germany—SCHUCHARDT & SCHUTTE, 59 Spandauerstrasse, Berlin. C. (Small Tools).
Germany—G. DIECHMANN, Ansbacherstr, 5 Berlin, W. 62.
France—FENWICK FRERES & CO., 21 Rue Martel Paris
France—F. G. KREUTZBERGER, 140 Rue de Neuilly Puteaux (Seine)
Chicago, Ill.—FRED. A. RICH, 23 So. Canal St.
New York City—F. G. KRETSCHMER, 136 Liberty St., Room 508.



CAR WHEEL BORER.

MACHINE TOOLS.
Complete Equipments.
RAILROAD, CAR, LOCOMOTIVE
AND GENERAL MACHINE SHOPS.

BRANCH HOUSES:
NEW YORK, CHICAGO, BOSTON,
PHILADELPHIA, PITTSBURGH.

THE NILES TOOL WORKS CO.,
HAMILTON, OHIO.

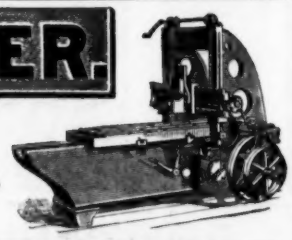
Correspondence Solicited.

Jenkins' Packing Is all right, so say thousands of Engineers. We have positively refused many times to cheapen the quality to compete with other makers. It is better to-day than when first put on the market 20 years ago. It is cheaper than many other kinds because it does not weigh as much per yard. It is honestly made, and will do all that any other Packing will do and has advantages that no other has.

NEW YORK. CHICAGO. JENKINS BROS. PHILADELPHIA. BOSTON.

BEMENT, MILES & CO., PHILADELPHIA, PA.
MANUFACTURERS OF
METAL WORKING MACHINE TOOLS
For RAILROAD SHOPS, LOCOMOTIVE AND CAR BUILDERS, MACHINE SHOPS, ROLLING MILLS, STEAM FORGES, SHIP YARDS, BOILER SHOPS, BRIDGE WORKS, ETC., ETC.
STEAM HAMMERS,
Steam and Hydraulic Riveting Machines.
New York Office, Taylor Building, 39 Cortlandt St. E. H. MUMFORD, Representative.

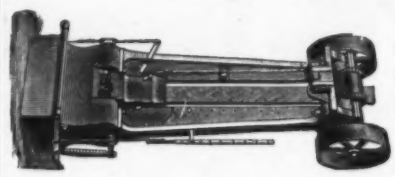
THE GRAY PLANER.
...Manufactured by...
THE G. A. GRAY CO.,
CINCINNATI, O., AND 121 LIBERTY ST., NEW YORK.
Send for list containing
Over 100 SIZES and lengths, with illustrations.



SCREW SLOTTING MACHINE.

THE GARVIN MACHINE CO.,
MAKERS OF AND DEALERS IN
METAL-WORKING MACHINERY
OF EVERY KIND.
Universal and Plain Milling Machines, Drill Presses, Screw Machines, Hand and Engine Lathes, Planers, Turret Lathes, Shapers, Gear Cutters, Die and Cutter Grinders, Tapping Machines, etc., etc.
A COMPLETE LINE OF
Special Bicycle Machinery.
Write for catalogues and list of new and second-hand machinery for immediate delivery.
Laight and Canal Sts., NEW YORK.
51 North 7th St., PHILADELPHIA, PA.

PRATT & WHITNEY COMPANY,
HARTFORD, CONN., U. S. A.

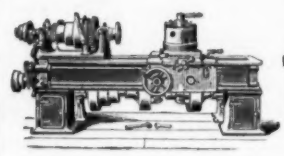


Have recently improved the construction of Drop Hammers and made substantial reduction in the price of each size from 250 to 1,500 pound machine.
Die Sinking, Milling and Profiling Machines and Trimming Presses are also offered at reduced prices. Quotations will be given on application.

THE BILLINGS PIPE WRENCH.
Jaw Drop Forged from the Best Tool Steel. Few Parts. Best Workmanship. Angle of Jaws the same irrespective of the size of pipe taken.

Length 14 inches. Takes Pipe from ¼ to 1½ inches.
THE BILLINGS & SPENCER CO.,
HARTFORD, CONN.
Chicago Office: 17 S. CANAL STREET.
England—CHARLES CHURCHILL & CO., 23 Cross St., Finsbury, London, E. C.
France—L. ROFFO, 58 Boulevarde Richard Lenoir, Paris. Russia—J. BLOCK, Moscow.

WARNER & SWASEY,
CLEVELAND, OHIO.
MANUFACTURERS OF
TURRET ENGINE LATHES.



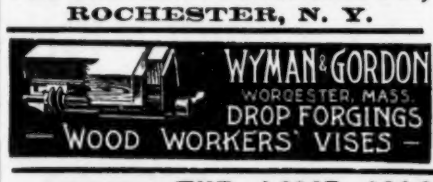
IRON AND BRASS WORKING MACHINERY.
SEND FOR ILLUSTRATED CATALOGUE.

FIELD TOOL CO.,
Manufacturers of ENGINE LATHES from 17 to 56 in. swing. Cuts, Photographs and Prices furnished on application.
Lowell, Mass., U. S. A.

THE HAYDEN & DERBY MFG. CO.,
SOLE MANUFACTURERS
METROPOLITAN INJECTORS,
AUTOMATIC AND DOUBLE TUBE.

Send for our New Book. Sent free.
"Practical Information on Injectors."
OFFICE AND SALESROOMS:
No. 114 LIBERTY ST., NEW YORK.

UPRIGHT DRILLS,
CUTTING-OFF MACHINES,
KEY-SEATING MACHINES
AND
SPECIAL MACHINERY.
Write for Catalogue and Prices.
THE W. P. DAVIS MACHINE CO.,
ROCHESTER, N. Y.



HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.
HARTFORD, CONN.

J. M. ALLEN, President.
WM. B. FRANKLIN, Vice-President.
F. B. ALLEN, Second Vice-President.
J. B. PIERCE, Secretary & Treasurer.

THE ACME MACHINERY CO.
CLEVELAND, OHIO.
Manufacturers of
ACME BOLT & RIVET HEADERS,
Acme Single and Double Automatic
BOLT CUTTERS.
Cutting from 1-8 in. to 6 in. diameter.
Also SEPARATE HEADS and DIES.

MACHINE TOOLS AT REDUCED PRICES.
In order to reduce our stock, we offer 16", 18", 21" and 24" engine lathes, 16", 22", 24" and 27" planers, 10", 12" and 15" speed lathes, 15" and 20" turret lathes, at a good discount from former prices.
We also have a few 16" and 18" second-hand engine lathes, in good order, and of our own make.
THE HENDEY MACHINE CO., Torrington, Conn.

J. M. CARPENTER
PAWTUCKET, R. I.
Manufacturer —of— TAPS & DIES